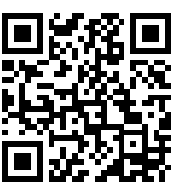
This is a reproduction of a library book that was digitized by Google as part of an ongoing effort to preserve the information in books and make it universally accessible.

Google™ books

https://books.google.com



UC-NRLF
$B 648 564

Digitized by Google

U.C.D. LIBRARY

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

# THE ROYAL ENGINEERS JOURNAL.

Vol. IX. No. 1. JANUARY, 1909.

CONTENTS.


| | PAGE. |
|---|---|
| 1. **Further Experiments with Palm Trees as Bridging Material.** By Bt. Major R. L. McCLINTOCK, D.S.O., R.E. (*With Photos*) ... ... ... | 1 |
| 2. **Inside and Outside Port Arthur.** By Col. J. F. LEWIS, late R.E. ... ... | 3 |
| 3. **The Italian Operations in Abyssinia, 1894 to 1896.** By Capt. F. D. IRVINE, R.E. (*With Plate*) ... ... ... ... ... ... | 13 |
| 4. **Territorial Field Companies, Royal Engineers.** By Major F. E. G. SKEY, R.E.... | 23 |
| 5. **Territorials of the 1st Century, B.C.** By Col. O. E. RUCK, late R.E.... ... | 27 |
| 6. **Lime and Cement Mixtures.** By Major A. H. D. RIACH, R.E. ... ... | 29 |
| 7. **The R.E. Headquarter Mess** (*continued*). By Lt.-Col. B. R. WARD, R.E. ... | 33 |
| 8. **Transcripts:**—The New Foot-Soldier. (Translated from the *Matin* by 2nd Lieut. A. H. SCOTT, R.E. ... ... ... ... ... | 41 |
| Dr. Sven Hedin's Expedition in Tibet. By Major C. H. D. RYDER, D.S.O., R.E. (From the *Geographical Journal*) ... ... | 43 |
| Railway Signalling.—Its Defects and Suggestions for Removing Them. By Capt. A. GARDINER, R.E. ... ... ... ... | 49 |
| 9. **Notices of Magazines** ... ... ... ... ... ... | 69 |


CHATHAM:
ROYAL ENGINEERS INSTITUTE.
AGENTS AND PRINTERS: W. & J. MACKAY & Co., LTD.

PRICE: 1s. 6d. POST FREE. ANNUAL SUBSCRIPTION: 15s. PAID IN ADVANCE.

U.C.D. LIBRARY

# HAWKES & CO., LTD.,

TAILORS AND MILITARY OUTFITTERS, CAP AND ACCOUTREMENT MANUFACTURERS,

14, PICCADILLY, LONDON.

*Patronized by many Officers of the Royal Engineers.*


The Council of the R.E. Institute having assumed Sole Control of Advertisements appearing in this Journal, applications for space should be addressed to

THE EDITOR, R.E. JOURNAL,
R.E. Institute,
CHATHAM.

Telegraphic Address: "SAPPER, CHATHAM."


## NOTICE.

# G. E. CARRINGTON,

## 53, HIGH STREET, OLD BROMPTON, KENT,

BEGS to inform his numerous Clients that, owing to the expiration of the lease at 6, CARLTON STREET, REGENT STREET, S.W., he will, after December 25th, 1908, have his London Room for Fitting, etc., at

**Carlton House, Regent Street, Waterloo Place, S.W.,**

and will be in attendance Personally at the latter Address every TUESDAY and THURSDAY, from 11 a.m. to 6 p.m., and at any other time by Appointment.


Digitized by Google

# CONTENTS.


PAGE.

1. FURTHER EXPERIMENTS WITH PALM TREES AS BRIDGING MATERIAL. By Bt. Major R. L. McClintock, D.S.O., R.E. (*With Photos*) ... ... ... 1

2. INSIDE AND OUTSIDE PORT ARTHUR. By Col. J. F. Lewis, late R.E.... ... 3

3. THE ITALIAN OPERATIONS IN ABYSSINIA, 1894 TO 1896. By Capt. F. D. Irvine, R.E. (*With Plate*) ... .. ... ... ... ... ... .. 13

4. TERRITORIAL FIELD COMPANIES, ROYAL ENGINEERS. By Major F. E. G. Skey, R.E.... ... ... .. .. ... ... ... ... ... ... 23

5. TERRITORIALS OF THE 1ST CENTURY, B.C. By Col. O. E. Ruck, late R.E. ... 27

6. LIME AND CEMENT MIXTURES. By Major A. H. D. Riach, R.E. ... ... 29

7. THE R.E. HEADQUARTER MESS (*continued*). By Lt.-Col. B R. Ward, R.E. ... 33

8. TRANSCRIPTS :—

The New Foot-Soldier. (Translated from the *Matin* by 2nd Lieut. A. H. Scott, R.E ) ... ... ... ... ... ... ... ... ... ... 41

Dr. Sven Hedin's Expedition in Tibet. By Major C. H. D. Ryder, D.S.O., R.E. (From the *Geographical Journal*, by permission) .. ... ... ... 43

Railway Signalling.—Its Defects and Suggestions for Removing Them. By Capt. A. Gardiner, R.E. ... ... ... ... ... ... .. ... 49

9. NOTICES OF MAGAZINES :—

*Bulletin.* By 'E.R.'... ... ... ... ... ... ... ... .. 69

*Kriegstechnische Zeitschrift.* By 2nd Lieut. A. H. Scott, R.E. ... ... 70

*Militärische Presse.* By Capt. E. G. Wace, R.E. ... ... ... ... 72

*Neue Militärische Blätter.* By Capt. E. G. Wace, R.E. ... ... ... 74

*Revista de Engenheria Militar.* By 'M.'... ... .. .. ... 76

*Revue du Génie Militaire.* By Capt. J. E. E. Craster, R.E. ... ... ... 78

*Revue Militaire des Armées Étrangères.* By 2nd Lieut. A. H. Scott, R.E. ... 79

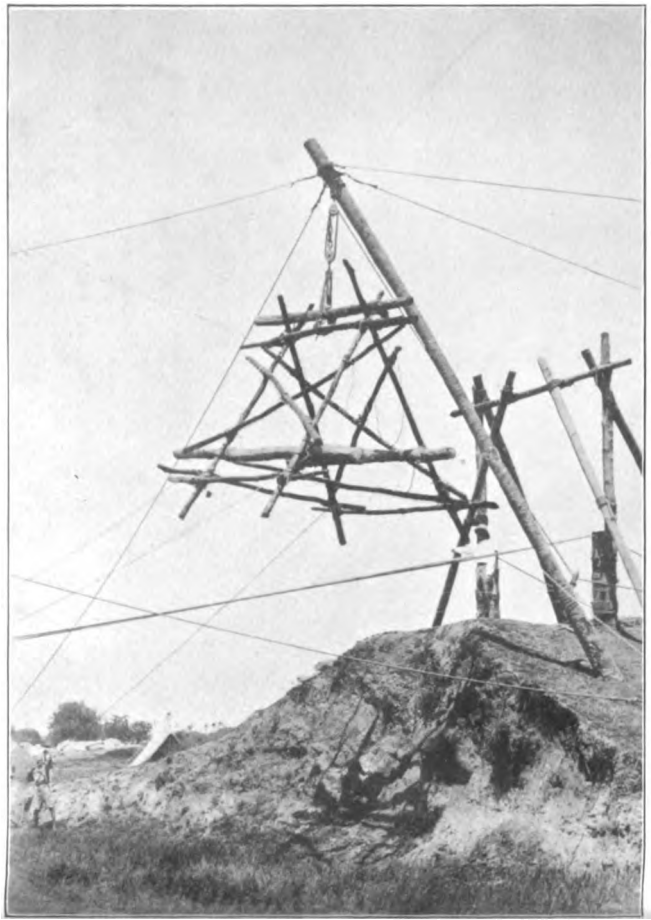

*Authors alone are responsible for the statements made and the opinions expressed in their papers.*

Digitized by Google

Digitized by Google

Digitized by Google

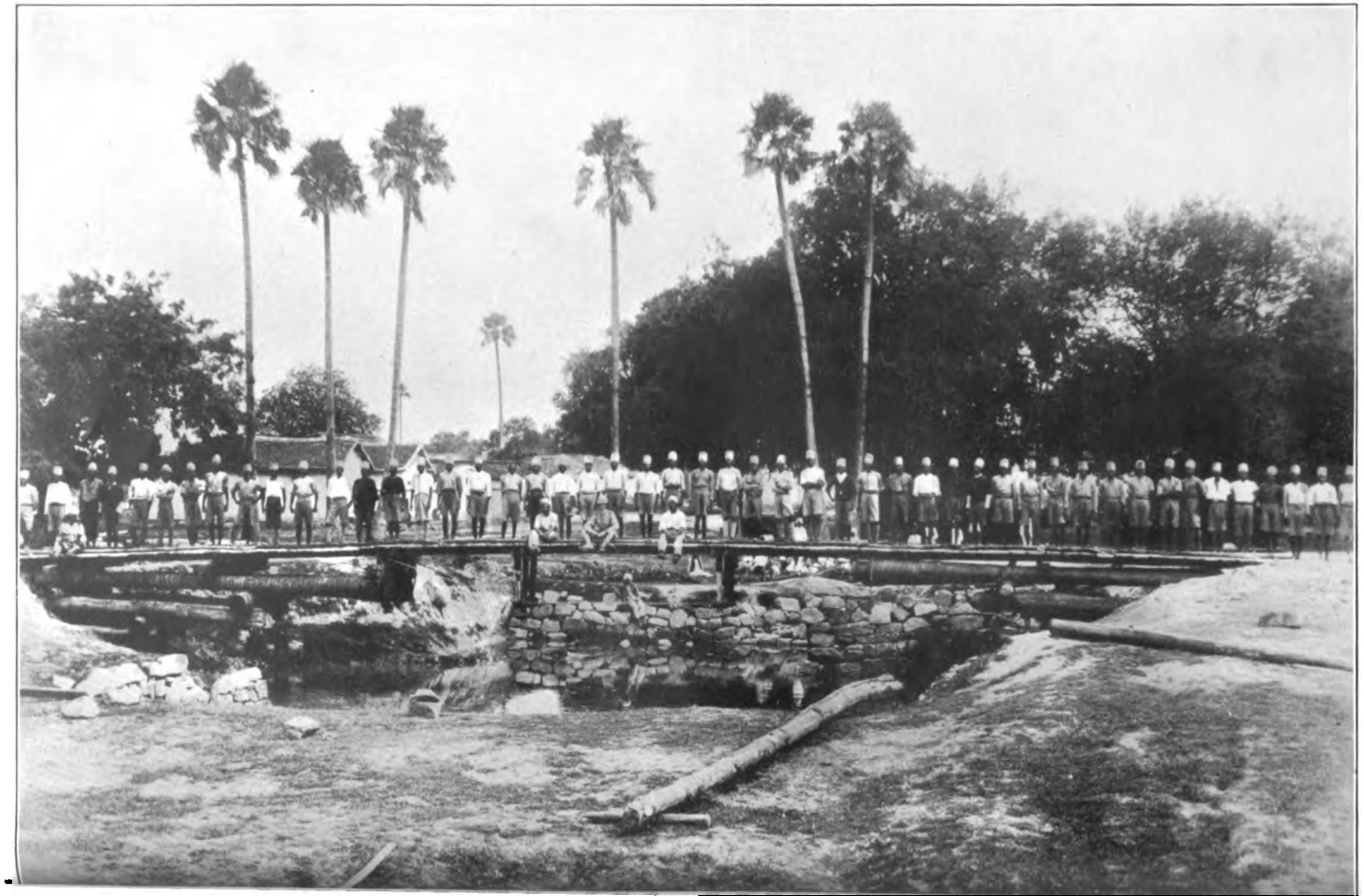
## FURTHER EXPERIMENTS WITH PALM TREES AS BRIDGING MATERIAL.



Digitized by Google

Digitized by Google

FURTHER EXPERIMENTS WITH PALM TREES AS BRIDGING MATERIAL.



Digitized by Google

# *FURTHER EXPERIMENTS WITH PALM TREES AS BRIDGING MATERIAL.*

*By* Bt. Major R. L. McClintock, d.s.o., R.E.

In the August number of the *R.E. Journal* last year, an article appeared entitled "Experiments with Palm Trees as a Bridging Material," and showed that this timber—usually regarded very much askance by the military engineer—is really quite capable of useful employment in temporary bridges, and other fieldworks expedients.

At the time the article was written, experiments with these spars had only been made as regards their use for road-bearers, trestle legs, suspension-bridge piers, and field observatories, for all of which purposes the material had proved satisfactory. The timber had not however been subjected to the very severe test of use in a cantilever bridge, as funds would not permit of the purchase of sufficient palm trees.

But this test was not forgotten, and during the next field-works course of No. 10 Company, 2nd (Q.O.) S. and M., the experiment was carried out with entirely satisfactory results, as can easily be seen in the accompanying photographs.

The cantilever bridge shown, was of 72′ span between shore transoms and was calculated for infantry in file. Each cantilever projected 21′ from the shore transom, the centre (30′) being occupied by three trussed girders, each constructed of two overlapping pontoon gunnels, braced with fencing wire. In each cantilever there were three layers of logs, the lowest projecting 6′, the middle 7′, and the upper 8′ from the last point of support. Each layer carried back 15′ from the shore transom into the bank, and was there lashed down to an anchor log buried 4′ at the far end. In addition to this, each of the three layers was covered with boards and about a foot of rammed earth.

It will be seen from the photo that the top layer only of each cantilever was made of palm trunks. Expense prohibited the purchase of the large number of trees required for the whole bridge, but as the stress was calculated equal in each log of each of the three layers, the fact that the top layer stood the test answers for the whole.

It will also be observed that the point of the left-hand cantilever sank about 1′, and had to have the transom built up accordingly. This was due to inadequate foundations having been provided for the shore transom on that side, which accordingly, when subjected to the

Digitized by Google

load, sank to this extent in the somewhat soft earth of the bank. Equilibrium was however reached at this point, and no further subsidence took place.

The provision of sufficiently strong foundations to the shore transoms is, perhaps, the most important and difficult point connected with this type of bridge.

In connection with the use of palm trees in field work, the smaller photos show palm trunks in use :—(I.). As a single derrick. The palm trunk is 35′ long, and was used as a single derrick to raise one of the trestles of a trestle suspension bridge on to the cables. Weight of trestle about 1,600 lbs. (II.). As a field observatory. A field observatory 107′ high, made by lashing two palm trunks together. The graceful curve seen in the top spar is the natural shape of that particular tree, and not a sign of weakness.

Digitized by Google

# *INSIDE AND OUTSIDE PORT ARTHUR.*

*By* COLONEL J. F. LEWIS, LATE R.E.

UP to the present almost all we knew of the Siege of Port Arthur had been from the point of view of the Japanese attack. We have now a book, *The Truth about Port Arthur*, written by a newspaper correspondent, Mr. G. K. Nojine, who was inside. This has been translated by Capt. A. B. Lindsay and Major E. D. Swinton, D.S.O., R.E. His account appears truthful and is often supported by official documents. A comparison of his account with that of a good observer on the other side, such as that which Mr. Ashmead Bartlett has given us in *Port Arthur: The Siege and Capitulation*, seemed likely to be interesting, and has here been attempted.

It may help readers to warn them that Russian time differs from Japanese time by one hour. Consequently, if Mr. Ashmead Bartlett says that an operation began at 10 a.m., Mr. Nojine will time it at 11 a.m.

A notable point about the Battle of Nanshan, brought out by a comparison of the Russian and Japanese accounts, is that it was so very nearly a Russian success. The Japanese estimated (A.B., p. 18) that 11,000 men were defending the position, while Nojine makes the statement on p. 11 that there were 16,000 men of the 4th Division alone behind the next line of hills. He adds, though, that they were never brought into action! Their general, Fock, wished to reserve them for the defence of the fortress, not realizing that the real defence of the fortress was here and now at Nanshan. As a result the 5th Regiment, which mainly defended the position, was worn out and exhausted by the end of the day and could not resist the last Japanese advance. The same misunderstanding of the situation had led to the defences being only half executed and only partly provided with accessories, such as electric lights and materials for bombproofs, and to a defective supply of ammunition.

Notwithstanding all these deficiencies, the brave Russian troops held on to the position through 12 hours of desperate fighting, repelling repeated Japanese assaults, until at length the fire of their batteries and gunboats enabled the latter to wade through the shallow water of Kinchau Bay and to turn the Russian left flank.

It appears to be generally admitted that a better position than that of Nanshan is to be found on the hills about 2 miles behind it, called by Nojine the Tu Fashin Heights (p. 75), but no attempt was

Digitized by Google

made by the Russians to hold these heights even as a support to Nanshan.

After the Battle of Nanshan, Dalny was evacuated in so much hurry that there was no time to destroy the docks, and the defenders of Port Arthur fell back almost into the fortress. An advance by General Nogi would probably have taken him nearly up to the glacis; but he did not know the disorganized state of the Russian forces, and was actually inferior in numbers to them, so he contented himself with covering Dalny, preparing it for use as a base, and sufficiently clearing Talienwan Bay of mines to allow of the use of the harbour by the Japanese transports.

The Russians, wishing to gain time for further works at Port Arthur itself, occupied the Green Hills position, about 7 miles in advance of the fortress, which was more or less fortified and was very strong in itself.

According to Nojine, the Japanese, on obtaining possession of Dalny, immediately began using it for the landing of stores (p. 89); but this could not have been the case, as the Bay had first to be cleared of mines, which was a slow process, and not sufficiently accomplished until the middle of July, according to Ashmead Bartlett (p. 31).

As part of the preparations for using Dalny, General Nogi was anxious to get possession of Kinsan Hill, a point in advance of the main Green Hills position, but one from which it was possible to see both Dalny and the environs of the Fortress of Port Arthur. It was therefore of importance to both sides.

On 26th June it was assaulted by a battalion, assisted by mountain guns, and stormed. According to the Japanese account, it was defended by two battalions (A.B., p. 29), but Nojine (p. 93) says there was only one company there, and considering the nature of the ground there can be little doubt that his statement is correct. On July 3rd the Russians made a desperate effort to retake it, but failed.

General Nogi was now able to utilize Dalny without fear of being overlooked, and by the third week in July felt himself once more in a position to assume the offensive. In the meantime the Russians—with the exception of the one attack on Kinsan Hill—made no attempt at a forward movement, although for some time they were in superior numbers to the Japanese.

The mental attitude of both sides towards forward movements is of interest to note. The Russian idea of such a movement seems to have been to take up an advanced position and to hold on to it. They do not seem to have thought of pressing forward to an attack except locally for a particular purpose.

The Japanese were ready to advance, but not until the balance of advantages was in their favour. When they had the right quantity of men and guns and ammunition then they went forward, and were delighted to do it.

Digitized by Google

Neither side seemed ready to take many chances. The Russians did not take up covering positions nor stop at points good for checking the enemy, if these had not been previously decided upon; nor did they advance even when they had the advantage, as was the case when the Japanese first occupied Dalny.

The Japanese, when they had gained the point they were aiming at, did not attempt to go further. A vigorous continued forward movement after Nanshan might have led to the destruction of a large portion of the retreating force, as they seem to have been in a very disorganized condition. Similarly, after the capture of Kinsan, further pressure on the line of the Green Hills would probably have broken it, and the Japanese, having forced the enemy's right flank, would have been in an advantageous position to roll up his centre and left.

Such a result was not possible later on. General Kondratenko was put in charge of the right flank and soon got it into better order.

This was seen in the fighting of the 26th, 27th, and 28th July, when the Japanese succeeded in forcing the position. The troops on the right flank retreated in good order and occupied the Taiho Heights immediately in rear, thus preventing the Japanese exercising more than direct pressure on the troops retreating on the Russian left.

The latter occupied the Wolf Hills just outside the fortress, but these were only imperfectly fortified, and were attacked and carried by the Japanese on the morning of the 30th July. The Russians also evacuated the Taiho Heights, which were too advanced to be held.

The accounts of the capture of Ta-ku-shan and Hsiao-ku-shan Hills are in agreement. The Japanese evidently expected a very obstinate defence of positions of such importance to the fortress, and made a powerful assault, which indeed was not on too extensive a scale. If the positions had been carefully fortified beforehand, they would not have fallen for a long time.

The capture of these hills marks the commencement of the actual investment of the fortress. It will be interesting at this point to note the state of the works and the manner in which they had been evolved.

At the time of the siege the Russians had been in occupation of Port Arthur for over six years. At first they seem to have been zealous about fortifying it, but apparently had slacked off afterwards, until General Kuropatkin visited the place in 1903 and set the work going again, making also some modifications in the design. However at the outbreak of war the defences were far from complete.

Out of the five "Forts," one was incomplete and one was not begun. This did not seriously matter, as these works were on the western side, which was not attacked.

Digitized by Google

The five "Fortifications," so named by Nojine, were complete; three of these were really forts. No. 3 is better known as Sung-shu-shan. Besides these, several of the intermediate batteries and redoubts were finished, some of them in a very solid manner in concrete. Besides the Russian works there were remains of the old Chinese redoubts, such as East and West Banrusan (Redoubts 1 and 2), and the Chinese wall, a continuous mud parapet running along the whole of the eastern defences and part of the western, which proved to be of the utmost value. It was never seriously damaged nor permanently passed by the enemy until the end of the siege.

None of the advanced positions had been taken up, such as Ta-ku-shan, the Suishien plateau, the "Mètre" Hills, or Liao-tieh-shan. After 9th February, 1904, when the Japanese made their first naval attack, the fortress was put in a state of siege, and work was carried on with more energy; but there was an immense amount to be executed, as not only had the fortress itself to be completed and developed, but the advanced positions at Nanshan, Green Hills, and Wolf Hills had to be prepared. As a consequence, nothing was quite strong enough when it came to be used.

According to Nojine, General Stössel, who was the evil genius of the defence, insisted on beginning with the Central Wall, an inner continuous line of entrenchment close to the town. This absolutely useless work, commanded by heights all round, absorbed an amount of labour which would have been most profitable if expended elsewhere. Stössel also at this time allowed the fortress to be depleted of supplies, a course which eventually led to the place running short of provisions and to an outbreak of scurvy. The want of any balloon equipment in the fortress is explained by M. Nojine, who tells us that the transport containing the balloons and other stores was captured by the Japanese.

On March 17th General Smirnoff, appointed commandant of the fortress, arrived there. General Stössel was really in command of the district of Kwantun, and was not entitled to interfere in the actual defence of the fortress itself, although he did so with evil results. Smirnoff at once inspected the place and, aided by the engineer, General Kondratenko, and others, set to work to get it into order. He had to finish the existing works and to arm them. He quite rightly devoted much attention to the N.E. section of the defences, where the main attack afterwards came off, and built many trenches and batteries. Not much was done on the west front, which was not exposed, but guns were mounted on Liao-tieh-shan to prevent the Japanese fleet bombarding the town from dead water to the westward, as it had done on 10th March.

He developed the works in the Suishien Valley, such as Temple Redoubt ("B" Lunette) and Water Supply Redoubt (Fort Kurapatkin), and commenced an extensive series of works in the

Digitized by Google

"Mètre" Range. According to Nojine, General Smirnoff wished to restrict the works there to 203-Mètre Hill and its immediate neighbourhood, but Stössel insisted on advancing to Angle Hill (174-Mètre Hill), and this involved holding more foothills to the front of that again. As a result, none of the works were quite strong enough. 174-Mètre Hill fell at an early period of the siege, and 203-Mètre Hill did not get the attention which the importance of its position deserved. Something was done to strengthen Ta-ku-shan and Hsaio-ku-shan (Shakozan), but not enough to enable them to resist a determined attack. Probably this was due to want of available labour, and also to the fact that the main line behind them was very strong; as a matter of fact, it was never attacked by the Japanese. It should be realized that an enormous amount of work was done under General Smirnoff. Miles and miles of trenches were cut in rocky ground, and hundreds of guns mounted. Besides the land front the coast batteries had to be attended to, and here additional guns were mounted, and greater effectiveness given to the original armament by increasing the arcs of fire and the angles of elevation.

There is not much fresh to be gleaned about the great assault of 19th—25th August. On both sides it seems to have appeared to be a sort of pandemonium lit with the glare of search lights, pointed with flashes of flame, and full of the roar and rattle of shells and rifles. The finish of it left both sides exhausted and the ground piled with thousands of corpses, many of which lay there till the end of the siege. The Russians lost the Banrusan Redoubts and 174-Mètre Hill, but the latter was not of high importance, and the former proved a barren acquisition to the Japanese.

The assaults on 203-Mètre Hill in September and the capture of Water Supply Redoubt (Fort Kuropatkin) and the Suishien Redoubts do not call for any remarks.

On 31st August and afterwards, Stössel issued orders which, according to M. Nojine, had the effect of checking the delivery of sorties. This must have rendered the task of the Japanese much easier when they got their approaches close up to the works. It was partly justified by the limited numbers of the garrison. Men could not be wasted.

At this time a third line of works was being constructed in rear of the N.E. defences, a line running about east and west from the front of Quail Hill.

It is interesting here to read a Russian criticism on the trenches made on 203-Mètre Hill, which were similar to those used elsewhere (see Nojine, p. 200). It is by Colonel Raschevsky. He points out that the loopholes are so close up under the roof that it is difficult to fire out of them at all, and impossible to fire down a steep slope. This was a general fault in the case of the Russian works. He also objects to the deep, narrow, boxed-in form of the trenches. This

Digitized by Google

was not altogether the opinion of the Japanese. They found it difficult to storm a trench from one end, as it was impossible to advance with any width of front. At the same time it was dangerous to pass over the trench and attack it from the rear, as they would be so terribly exposed to the fire of collateral works. Besides this, the trenches were as safe as they could be made from artillery fire. It is however absolutely necessary that such trenches should be well supported by fire from behind and from the flanks.

We now begin the serious work of the siege, properly so-called, when the permanent forts were attacked step by step and when the heavy howitzers were brought into use.

These howitzers were of 11″ calibre and fired a shell weighing 550 lbs., and had been previously used on coast defences. The first one arrived at the besiegers' lines on September 9th, and on 1st October they began firing into the town. It is noted as "an epoch in the history of the defence of Port Arthur." The shells broke through any bombproof or casemate that they struck ; no one felt safe anywhere, and the permanent forts were no more secure against them than the trenches.

The Japanese were now sapping towards the forts on the N.E. front, and in particular were close to Chi-kuan-shan. Here, on arriving at the end of the glacis, which finished in a 1/1 slope, they began mining to blow in the back of the counterscarp gallery.

The Russians became aware of this, and started countermining from the gallery so as to get under the Japanese mine and destroy it. They intended to fire a camouflet (Nojine, p. 215), which would destroy the enemy's gallery without producing any effect at the surface.

The Russian mine was fired with some enthusiasm by the commandant of the fortress, General Smirnoff, himself, but there seems to have been some miscalculation of the charge, as a quantity of *débris* was thrown into the air, and a crater was formed which was rather of advantage to the Japanese than otherwise, as it formed a lodgment for them and a point for starting a new mine.

Nojine does not say much about the fighting in and about the counterscarp galleries of Chi-kuan-shan. It probably did not come to the notice of a newspaper correspondent, as there was very little visible sign of it, but for awful desperation it must be unmatched in the history of warfare. Ashmead Bartlett tells one something about it in Chapter XVI.

There seems to have been an idea about Chi-kuan-shan (Nojine, p. 215) that the whole fort was mined and might be blown into the air. The same idea later on was held about Fort Sung-shu-shan. It was of course quite unfounded. Such extensive galleries as this would require could not be cut in the rocky soil of Port Arthur without the expenditure of more time than could be given to them, even if such an explosion could have been practically brought about.

Digitized by Google

There is not much to be made by a comparison of the accounts of the fighting on 29th and 30th October. There is a terrific bombardment, a daring assault, the reserves pour in upon it from the flanks, the Russians begin to use their diminishing stock of shrapnel; after a time the remains of the assaulting columns drift back again; both sides settle down to recover themselves, and the Japanese have made a slight advance.

Nojine says nothing about the mining attacks on the counterscarp galleries, Erh-lung-shan (Nirusan) (Fort No. 3), or on Sung-shu-shan (Fortification No. 3), notwithstanding their great importance in the progress of the siege. The different steps of the gradual Japanese advance were not very visibly dramatic, and probably so escaped being recorded. On the Japanese side the value of each little forward movement was more clearly appreciated.

We have a picture of General Nakamura's wild assault from both sides. He led a charge of volunteers—2,000 of them—against the supporting battery (Tumulus battery) behind Sung-shu-shan. The advance was over a perfectly open grassy slope, exposed to the Russian fire in all directions. The columns were shown up by the search lights before they started, but they came on all the same, climbed the hill—and never arrived at the top. They were all shot—all—and the grassy slope remained carpeted with corpses till the end of the siege.

The capture of 203-Mètre Hill reads much the same from both sides. The absolute determination of the Japanese to take it at any cost of men enabled them to wear down the defensive strength of the Russians till their reserves were exhausted and there was no one left on the hill to defend it. The bombardment was such that it is difficult to believe that any troops in the world could stand it—except the Russians, who have proved that they could. The Japanese lost over 9,000 men killed and wounded on these slopes.

It appears to be agreed on both sides that if 203-Mètre Hill had had a permanent work on it, it could not have been captured. It would have had to be attacked by sap and mine as the other permanent forts were, but the approach at 203-Mètre Hill is much more difficult than it is on the N.E. front. At the beginning of the siege there was however an immense amount that had to be done, and there was in addition a large quantity done for which there was no real necessity, so that there was no possibility of putting an adequate amount of work into 203-Mètre Hill. If Stössel had only put the rock-cut ditches of his Central Wall on the hill!

The day after the capture of 203-Mètre Hill the Japanese began to shell the Russian warships, directing their fire from the hill. The ships were mostly scuttled in the harbour by the Russians to reduce the effect of the shells upon them, with the idea that if they held the place they might be raised again. The *Sebastopol*, which was the

Digitized by Google

only uninjured one, went out of the harbour, but was eventually sunk in deep water. Admiral Togo himself landed and went to 203-Mètre Hill to be satisfied that he had seen the last of the Port Arthur fleet, and that he could now devote all his energies to preparing his ships and crews to meet the Baltic fleet, which was on its way out.

The fleet being thus disposed of, the Japanese were able to concentrate their attention on the capture of the fortress, and the centre of interest again shifts to the N.E. front.

Here the chief event, though of course the Japanese did not know it at the time, was the death of General Kondratenko on 15th December. He was killed with several other officers by an 11″ shell in one of the casemates of Fort Chi-kuan-shan, where he had gone to see how matters were progressing. He was Smirnoff's right-hand man, and with his tact as well as his skill had managed to keep things going. Now that he was lost the end was not far off.

On the 18th inst. the Japanese exploded their mines under the front parapet of Chi-kuan-shan. Their position is shown in the plan at p. 232 of Mr. Ashmead Bartlett's book.

It was more or less expected by the Russians, who do not however appear to have countermined. The Japanese charged almost into the explosion and occupied the craters, but could for the time get no further. The garrison was retrenched, and a tremendous fire was opened on the fort from the adjacent works. In the evening fresh troops were sent in, and the place was carried. It appears that the garrison was worn out, and no reinforcements were sent. General Kondratenko's successor had not the same ideas as to a defence as he had.

The next great event was the capture of Fort Erh-lung-shan (Nirusan) (Fort No. 3) on 28th December. The accounts differ as to how this came off, but on the morning of that day the Japanese exploded mines laid under the front parapet, similarly to those at Chi-kuan-shan (see plan, A.B., p. 240). They then occupied the craters, where they built some sandbag parapets, and after reconnoitring the rest of the work, stormed it, and finally captured it before daylight next morning, killing a number of the garrison in the concrete casemates of the gorge. According to the Russian account, the fort was simply evacuated, as the men had lost heart, notwithstanding that reinforcements had been sent to them immediately after the explosion. The Japanese account is more complimentary to the Russians, who, they say, fought desperately, and the large Japanese losses, amounting to 1,000 killed and wounded, show that there must be much truth in it.

While these operations were going on, Sung-shu-shan (Fortification No. 3) was waiting to be blown up, and on the 31st December the expected explosion occurred. As with the other forts, the front parapet was destroyed, but there was a different sequel. As the garrison was

Digitized by Google

rushing to the front through a gallery of communication, to repel the expected assault, another explosion occurred in the centre of the fort—in the gallery, not in the gorge—which killed a number of men, and drove the rest back into the gorge gallery itself, where they surrendered.

Both books, Nojine's and A.B.'s, say that a mine gallery was run by the Japanese from the front to under the gorge, in order to blow up the whole fort. This I have every reason to believe is incorrect; as a matter of fact, the gorge casemate was not blown up, it remained intact when the fort was captured, but the middle of the communication gallery was blown to pieces. There is little doubt that a mine laid by the Russians, to be exploded if the fort was taken, went off prematurely. They laid such mines in Chi-kuan-shan (Fort No. 2), but these were discovered by the Japanese in time to prevent them doing any harm.

The mining attack on these three forts is of considerable interest. In all cases the Japanese mined the front face, successfully stormed it after the explosion, and secured their position on the crest of the crater. In all cases the Russians continued their resistance, and in the case of two of the forts it was several hours before they were completely occupied. In the case of the third, the second unexpected explosion killed many of the garrison and imprisoned the rest in the gorge casemates, so that further resistance was impossible. At Chi-kuan-shan the garrison was exhausted and was not reinforced. When Erh-lung-shan (Fort No. 3) was taken there is little doubt that the heart had been taken out of the men by the progress of the siege, and they did not resist in the way they had before.

It seems therefore that the explosion of these mines did not with certainty advance the Japanese beyond the edges of their craters. If the garrison had been in good form the assailants would very likely have had to mine their way into the gorge before they could have completely mastered the works.

The fall of Sung-shu-shan gave Stössel what he considered sufficient excuse for surrendering. Orders were given to abandon some of the advanced works, which were occupied by the Japanese on the night of the 31st December, and on 1st January they stormed Eagle's Nest (Bodai). This was the key of the second line; no attempt was made to defend the third line.

On the afternoon of 1st January Stössel sent a letter to General Nogi proposing a capitulation. As soon as this got known the soldiers, relieved from the intense strain of the last months, got out of hand and no further defence was possible, even if it had been attempted.

At the surrender, besides other provisions, there were 700 tons of wheat flour and 1,920 horses. There were also 6,000 cases of scurvy in hospital, besides others still on duty. If these men had had the wheat

Digitized by Google

and the horses to eat they would probably have been in an efficient condition. A reinforcement of 6,000 men would have materially delayed the Japanese advance. Nojine states that on 8th December it was proposed to increase the meat ration, but that this was vetoed by Stössel.

The comparison of the two accounts of the siege shows that if the courage and devotion of the Japanese had not been seconded by muddle and mismanagement inside the fortress they would have been very much longer in taking it than they were.

Even supposing the place to have been in the state it actually was on the outbreak of war, and that no more had been done before that time, it could have been made enormously stronger—work could have been concentrated on vital points, provisions could have been accumulated, and proper hospital accommodation arranged for. This would have practically added several thousand men to the fighting strength of the garrison, and would have put much further off the day when they would have had finally to surrender from starvation. It is questionable if under such conditions anything else would have turned them out of the place.

Digitized by Google

# *THE ITALIAN OPERATIONS IN ABYSSINIA, 1894 TO 1896.*

*By* Capt. F. D. Irvine, R.E.

The Italian operations in Abyssinia have not, I think, received that attention from the military student which they deserve. The disaster of Adowa is usually regarded rather as an inexplicable fact, than as the logical outcome of previous action.

General Baratieri is remembered as the loser in the last great battle, while his victory at Coatit, the pursuit of Senafé, and the gallant defence of Mekeleh are forgotten, and in their successes against the Dervishes—operations which are as brilliant as those of British troops in the Sudan—the Italians display no signs of weakness.

To what causes then should we attribute their ultimate failure against the Abyssinians? It is customary to class these warriors on a par with other savage nations of the African continent, whereas the Ethiopian, to give him his true title, is possessed of a civilization far ahead of the Zulu or the Dervish. He is a remnant of the patriarchal days of the Old Testament, and his kings claim, with every right, direct descent from Solomon.

It is true that at the date of the British Expeditions which ended at Magdala, King Theodore's troops were not armed with the weapons of modern warfare, but when the Italians encountered Menelik they met a host of fierce warriors, some 120,000 in number, the majority of whom were armed with modern rifles which they knew how to use, and who were, in addition, embued with the reckless courage of the Zulu or the Dervish. In fact they may be better compared to the hill tribesman of the N.W. Frontier of India, or to the Afghan, though I doubt whether these cautious customers possess the same ability to charge home in the face of an overwhelming fire as—on countless fields—the African has shown himself able to do. Nor has it ever been the lot of British troops to encounter in country similar to—if not more difficult than—Afghanistan, such enormous hosts of well-armed fanatics, so that possibly we have condemned the Italians too lightly for their failure, and have not sufficiently studied the difficulties of the situation.

A brief account therefore of some of the salient features of the various Italian operations in Abyssinia may, perhaps, serve to interest the student.

In 1889 Menelik, King of Shoa, seized the throne of Abyssinia,

Digitized by Google

which was vacant by the death of the Emperor John on the battle-field of Matamma, where he had signally defeated the Dervish hordes. This battle is mentioned merely to show that at that time, the Abyssinians were superior from a military point of view to the Dervishes, then at the zenith of their power. John was King of Tigré—Shoa and Tigré being divisions of the Abyssinian kingdom—and Menelik, who is a politician rather than a warrior, having refused to join John against the Dervishes, after his death ousted Mangasha, who was a minor and who was heir to the throne of Tigré.

In January, 1890, the Italians formed their "Colony of Erithria," and had to select which of the two, Menelik or Mangasha, they would support as paramount in Abyssinnia. Rightly or wrongly, they decided to support Menelik. In return for the concession of acknowledging an Italian protectorate, Menelik was allowed to borrow four million lire (£150,000), half of which sum he at once expended on rifle cartridges.

After endless negotiations, and on the arrival of these cartridges at Addis Abeba—the Shoan capital—in February, 1893, Menelik repudiated all treaties and sent a circular note of independence to the Powers of Europe. However negotiations still continued, and in the meanwhile the raw Italian native troops were blooded against Dervish raiders at Agordat and Kassala. In all the negotiations it was invariably the unfortunate province of Tigré, the property of Mangasha, which was divided between the Italians and Menelik, until at length in June, 1894, the Prince of Tigré, in despair of receiving help from Italy, joined Menelik, and with the assistance of that monarch commenced to collect forces with which to recover his kingdom.

At this point it is necessary to give a brief description of the opposing forces. The Italian native troops were recruited from the borders of the Red Sea, and from Tigré and the surrounding chiefs. The officers were Italians at roughly 1 officer per 100 men. The *esprit de corps* and fidelity of these native troops, called Ascari, is undoubtedly as great as that of our Indian troops, and there are numberless instances on record of their loyalty and devotion under the most trying circumstances. The cavalry arm was practically non-existent, but the artillery, of mountain guns only, was manned by Sudanese and was most efficient. The total garrison of the colony in 1894 was some 13,000 Italian and native troops, with two squadrons of native cavalry and two mountain batteries.

As regards the leaders, General Arimondi, at Agordat, signally defeated a Dervish host of four times his strength, and the Governor-General, Baratieri, by a sudden dash with 2,500 native troops, had captured Kassala—a Dervish stronghold—which became the outpost of the colony.

The numbers of the Abyssinians depended somewhat on the

Digitized by Google

support accorded to the Negus Nagasti, or Emperor, but at this time Menelik could actually dispose of some 200,000 men. About two-thirds only of these were armed with rifles, breechloaders of various sorts, but every man knew how to use the rifles taken from a dead comrade. They were fair marksmen, and every warrior carried the six-foot Ethiopian spear. The cavalry, from Galla in the south, were not the least efficient portion of the force, which was completed by the possession of artillery in the shape of mountain guns.

Like most semi-civilized nations, they had no organization in battle and had a dislike to night operations. At the halt there was no service of protection, and they were accompanied by enormous numbers of followers; an army on the move was like the emigration of a tribe. The matter of supply therefore was their vulnerable point; each district was soon eaten bare, and then if a move was not made, the army disbanded itself.

In operations against such an enemy it is necessary to deny them the fertile districts, either by means of forts built and occupied in peace, or by placing the regular forces in such a position as to cut the enemy off from his next means of supply, thereby forcing him to attack or to disband, when vigorous action will turn his retreat into a rout.

To resume. In December, 1894, Mangasha, with a force of 18,000 men, took up a menacing attitude at Entisho. Baratieri, with 3 battalions and a battery, made a sudden dash from his base at Adis Ugri and occupied Adowa and Axum, the Tigrian capital and sacred town.

The effect of this stroke however was less than he expected, and in January he returned to Adis Ugri to watch Mangasha. The latter was bent on invading Okulé Kusai, the north-eastern portion of Tigré, and was thus liable to attack on his flank. Baratieri therefore moved to the heights of Kenafena, where he would be in a secure position and within striking distance. On January 12th, 1895, on secret information, he crossed the river Mareb to Adis Adi, and from the heights of Mount Toculi the enemy's column could be descried moving northwards on Coatit.

Baratieri decided to cut him off, and marched on the same day to Coatit, which he occupied in the evening, unknown to the enemy, with a strength of 4 battalions and 1 battery, all native troops. Mangasha camped some 4 miles to the south-east, and Baratieri, after a night march, attacked at dawn, 13th January. The Abyssinians made vigorous efforts to envelope the Italian left and reach Coatit, but they were foiled, and at 10 p.m. Mangasha retired with enormous losses. The pursuit was taken up at dawn on the 14th January, through the Cascassé Pass to Senafé, where, after a distance of 30 miles had been covered, the Abyssinians were found camping at sunset, and were absolutely routed, abandoning everything. This is

Digitized by Google

a prodigious pursuit for infantry, and any small body of cavalry would have been of incalculable value.

So far the war was over, and when the disparity in numbers is considered, the operations afford undoubted proof of the ability of General Baratieri and of the staunch character of the native troops. The total Italian loss was 600 out of 4,000, while that of the Tigréans is estimated at 3,000. The only drawback to the success achieved was that possibly too low an estimate was formed of the opposition likely to be encountered from Menelik.

The Governor now proceeded to consolidate his position in Northern Tigré; but in Italy the Crispi Government was in power, and the strictest "economy" was the order of the day. Consent was given to the fortification of Adigrat, a position of immense strength and importance, but all the Governor's applications to build a fort and to occupy Adowa were in vain. He was compelled to give in on the point, and in doing so rather than resign, he, without doubt, in a measure sealed his future fate. He and his advisers saw that further operations were inevitable, that the line of mountains between Adigrat and Adowa formed the strongest line of defence for the Italian Colony, and that they also barred the way to the fertile districts of northern Tigré. Italy however could not afford war, and a backward policy was adopted.

Meanwhile Menelik had been busy consolidating his empire, and at the end of September prepared to take the field by sending reinforcements to Mangasha at Debra Aila as an advanced guard. The Governor determined to strike this force before Menelik could come up, and concentrating at Adigrat moved swiftly down to Dolo. He had been reinforced from Italy, and was now in command of 9,000 Italian and native troops, 2 batteries, and some irregulars. Mangasha evaded the blow and retired southwards to Lake Ashangi. Here again a body of cavalry on the Italian side, could probably have cut off and arrested the Abyssinians until the infantry arrived, and at any rate would have been useful in pursuit.

Baratieri, having occupied Mekeleh with $4\frac{1}{2}$ battalions under General Arimondi, and having sent $1\frac{1}{2}$ battalions under Major Toselli with 4 guns and the irregulars to Amba Alagi to watch Mangasha, returned himself to Adigrat to settle his communications, receive reinforcements, etc. Amba Alagi is a mountain pass 36 miles to the south of Mekeleh, and was merely a post of observation not intended to be defended. In fact it was eminently suited for occupation by cavalry, whereas infantry in such an isolated position are always liable to be caught by a mobile enemy. Moreover, a mutilated telegram from Arimondi led Toselli to think that his duty was to hold the pass and that he would be reinforced.

On December 7th Mangasha with 30,000 troops advanced on Toselli, who had only 1,200 regulars and 4 guns. The position is a

Digitized by Google

fine one, but the numbers of the defence were totally inadequate, and after six hours' stubborn fighting the Italian troops were overwhelmed, their leader killed, and a column of 300 fugitives reached Arimondi at Mekeleh. Some 3,000 Abyssinians fell, but the loss of prestige was a heavy blow to the Italian cause. Fortunately, like most half-disciplined troops, the Abyssinians failed in pursuit, and Arimondi was given time to make his plans. He left a garrison of 1,200 men and 4 guns under Major Galliano at the half-finished fort of Mekeleh, and with the remainder rejoined his chief at Adigrat. While admitting the virtue of an endeavour to check the enemy's advance and keep some hold over Southern Tigré, the wisdom of exposing a second detachment in this manner is very questionable, and Arimondi was censured by Baratieri for his action.

The Abyssinians waited for Menelik and gave Galliano 14 days' grace in which to finish his fort and make his preparations. On December 20th Menelik arrived with a host of 70,000 men and 20 guns, and the siege commenced. It lasted for 32 days, during which, at one period, a determined assault was kept up for five consecutive days with intermittent fire from the guns at night, a terrible strain for the tiny garrison. On January 19th water had run short and the end seemed near, when unexpected news arrived that the surrender of the fort had been agreed upon between the Italian Government and Menelik, and the gallant defenders were to march out with all the honours of war.

As a matter of fact, Menelik's host had exhausted the supplies of the district and it had become necessary for him to make a move. He wished to move to Adowa, thus making a flank march within striking distance of Adigrat. And, though he knew that a few days must decide the fate of Mekeleh, his cunning suggested a plan by which he could make his move with safety and certainty, and at the same time appear to be magnanimous. Under pretence of fears for the safety of the garrison, on their march out he insisted on sending with them a large escort. Mekeleh to Adigrat is 40 miles, and to Adowa 50 miles. When the escort reached Dongolo, about half-way, they and their prisoners moved in a north-westerly direction to Hausien, which is half-way between Adigrat and Adowa. Under cover of this screen Menelik effected the move of his main force to Gundupta, near Adowa, and on his arrival there, the escort screen retired, and the survivors of the siege were allowed to proceed to Adigrat.

The folly of the abandonment of Adowa was now apparent, but it was too late. Menelik was now nearer the Italian line of communications, through Asmara, than Baratieri, and the latter in order to cover them moved to Sauria, some 7 miles from Gundupta. Menelik however at once retired to Adowa, 4 miles to the west.

The Italians were in an extremely difficult country, full of

Digitized by Google

mountains, precipices, and deep nullahs. Their line of communications took 10,000 men for protection, and lay through Adigrat, Senafé, Adi Caji, where it divided, one line through Maio, and another by Sanguinetti and Asmara to Massowah. This line was double, extremely long and difficult, and very vulnerable, lying as it did through the mountains. In fact, it was cut on several occasions and caused constant anxiety.

Baratieri, in place of an advance through the mountains, would have done far better to garrison Adigrat and Adagamus strongly and move his main force to the river Belesa, with his communications shortened, simplified and comparatively safe, for the northern districts had long been under the Italian sway, and the chiefs were friendly. He could then have awaited the further movements of the Abyssinians, with the prospect of reinforcement by the two divisions now on their way from Italy. But with his lack of cavalry he had to watch the Abyssinians with his main body of infantry, and he also made the fatal error of underestimating both the numbers and fighting qualities of his enemy. Menelik, superior though he was in numbers, was far too acute to attack the Italians in a prepared position, and so on February 3rd the two sides sat down to watch one another. Baratieri now had a force of 21,000 Italian native troops and 50 guns. While however the inaction, combined with scanty food and bad supply arrangement, affected the *morale* of the Italian troops most adversely, Menelik, by means of spies, was kept aware of every plan and intended movement.

Daily the situation on both sides became more critical; on several occasions Baratieri ordered and again countermanded a retirement, until at last, on February 28th, he saw that he must make some move. Had he known that Menelik was also at his wit's end, Baratieri might yet have won his game of passive defence. Unfortunately all the Italian generals were unanimously in favour of an advance, and the Governor allowed his own judgment to be overruled. On February 29th therefore an advance by night to Gundupta was determined on, and he hoped that the Abyssinians would attack him there.

His force now consisted of:—

| | | | | |
|---|---|---|---|---|
| 8 regiments of Italian infantry | ... | ... | ... | 8,000 |
| 7 battalions of native infantry... | ... | ... | ... | 7,000 |
| 9 batteries of Italian mountain artillery, | | | | |
| 1 battery of native „ | „ | | | |

a total of 15,000 rifles and 56 guns, but no cavalry. Besides this there were some 1,500 irregulars and a mixed force of 3,000 as guard to the camp at Sauria.

The Abyssinian forces are estimated at 80,000 rifles, 8,000 cavalry, and 42 guns, with 20,000 men variously armed, but capable of using rifles when they should get them. This is a comparative strength of

Digitized by Google

6 to 1. At Omdurman the Dervishes were only 2 to 1, and had no rifles nor guns. At Tel-el-Kebir the numbers were again 2 to 1, though Arabi's troops had rifles and guns. In Tirah the total enemy encountered at all times never amounted to 50,000, in fact, it is safe to say that such a host as that of Menelik is unique in the history of uncivilized wars of modern times.

To resume our account of the ill-fated Italian force. It was divided into three columns and a reserve. The mountain tracks, though numerous, were extremely difficult to traverse in the dark. The maps were bad, and in his instructions to the left, or south, column General Baratieri made an error in the name of the heights which this column was to occupy. The place which he named lay in reality 3 miles further west and in front of the position selected. In spite however of all the difficulties, which included the unforeseen crossing of two columns, also due to the defective map, the various columns arrived on the ground allotted them in plenty of time to take up their positions. The left column however, marching quickly, arrived so early at its correct rendezvous that General Albertone, in command, after waiting some time for the centre column, which had been delayed by the crossing, to come up, concluded that he had made a mistake, and accordingly advanced to the place which was named in the map, 3 miles to the front.

At 6 a.m. on March 1st this isolated column met the enemy, who had news of the move, in force. It was Mangasha and his Tigréans, burning for revenge, and by 10 a.m. the Italians were overwhelmed and almost annihilated, the Sicilian gunners dying at their posts. At 7 a.m. Baratieri, who had been busy on the right, heard of the predicament of his left, and at once, in order to extricate Albertone, issued orders to the right column, under General Dabormida, to advance a short distance to a spur, and to hold out a helping hand to the hard-pressed left.

Owing to the difficulties of the ground however the advance was slow, and General Dabormida, losing his way among the ravines, strayed further and further away to the west and north. A huge column of Shoans, interposing between the right and left columns, rushed down upon the unprotected right of the centre column, which was in position under General Arimondi, and at this moment the victorious Tigréans, following the routed left, also attacked the centre. The reserve was brought up as quickly as possible to occupy both flanks, but they were defeated as they came on the ground, and a fresh column having enveloped the left of the centre at 2 p.m., the rout of the latter and the reserve became general. The Galla cavalry headed the fugitives off from the camp, but only pursued for some few miles. On March 3rd the remnants under General Baratieri reached Adi Caji, and the bad news was sent to Italy.

Meanwhile General Dabormida and the right column were busily

Digitized by Google

engaged with other forces of the enemy. At 9 a.m. he was heavily attacked, and by noon the enemy was completely beaten off. Now however the victorious Shoans and Tigréans returned from their successes on the centre and left, and General Dabormida was surrounded.

Momentarily expecting reinforcements, or at least some news, he fought bravely until 4 p.m., and then commenced to retire in good order. All the efforts of the Abyssinians failed to turn this retirement into a rout, and at sunset a tropical storm put an end to the fighting on both sides. General Dabormida was killed, but the survivors of this right column, covered with glory, made good their retreat to Adi Caji. Thus ended the Battle of Adowa.

The total loss on the Italian side was 4,000 Italians and 2,000 Ascari dead, 1,500 wounded, and 1,500 Italians and 1,000 Ascari taken prisoners. The Italian Army had ceased to exist, with 60 per cent. of its strength *hors de combat*. The Abyssinian losses are estimated at 17,000, or about double the Italian killed and wounded. Of the Italian officers, out of 400 some 300 were killed and wounded. The Governor was the only general who survived, to his misfortune.

On March 6th General Baldissera arrived to take over supreme command, and bent every effort to the organization of a force with which to stay Menelik's victorious advance. That monarch however, after advancing to Gura, suddenly drew off all his forces into Shoa. As a matter of fact he showed a wisdom above the average in resting content with his success and not pressing the Italians too hard. He had vindicated his statement that he only wished to recover the limits of his own empire, and he displayed great command over his heterogeneous force.

Peace was arranged in May, and the ancient line of the rivers Mareb, Belesa, and Muna became the recognized boundary, while the independence of Ethiopia was universally recognized. It only remained for General Baldissera to clear the northern portion of Erithria, which was threatened by the Dervishes under Osman Digma, as Menelik's ally. Kassala was relieved on April 3rd, and the Dervish Army routed at Tucruf. We have now come to the end of the operations, and it only remains to make a few comments on them and to bring out some of their salient points.

In all operations against a comparatively uncivilized foe, the civilized power possesses certain advantages. The first and foremost of these is the command of the sea or other avenues of approach to the enemy's country, so that it is possible to transport forces at will, to shorten lines of communication, or to relieve pressure on any point by a stroke from a new direction. This advantage was in no way utilized by the Italians in these operations. By shifting the base from Massowa to the Bay of Arafali, the line of communications would have been shortened and simplified, while an expedition landed

Digitized by Google

at Assab Bay to move through Danakil straight on Shoa could not have failed to draw Menelik from the north. This latter point indeed was considered, but the point and route chosen lay through the British and French spheres, and leave could not be obtained to make use of them.

Again, the power to look ahead and make preparations in peace is a factor on the side of civilization. In these operations, as in so many others, a policy of false economy was adopted, and the Government, in refusing the plain warning of the man on the spot, must shoulder their share of responsibility for subsequent mishap. How many similar monuments to the fatuity of party government in military matters might be erected in various parts of the globe.

Generally speaking, in uncivilized warfare, though the advantages of strategy lie mostly with the savage races, in tactics the reverse is the case.

These campaigns afford decisive proof that, even in mountains, the Regular forces cannot dispense with cavalry, the only arm with which the superior mobility of the savage can be counteracted. In artillery too the Italians seem to have been content with too little. Possibly the nature of the country rendered the employment of field guns impossible, in any case mountain guns are but a poor substitute, unless the enemy has no artillery.

In the service of intelligence the Abyssinians, as is usually the case, completely outwitted the Italians, but there is nevertheless no excuse for mutilated telegrams and the lack of maps.

The use and abuse of night marches is well illustrated. At Coatit the night march was successful because the enemy were surprised and were struck at dawn. At Sauria, on the other hand, General Baratieri was in a false position. He had 11 miles to traverse before he could strike the enemy, who were fully aware of all his movements. He should at any rate have moved to Gundupta by day and left 4 miles only for his march that night.

In 1898, at the attack on Mahmud's Zeriba on the river Atbara, the Sirdar, who was encamped 11 miles from the Dervish position, moved, first to Umbabia, then that evening to Mutrus, 3 miles from the zeriba, which he attacked at dawn after a night march. In this case, as at Adowa, the enemy were not indeed taken by surprise, but they were attacked at an hour which the savage particularly dislikes, and the assault was well prepared by artillery fire.

The Italian tactical formation is a shoulder-to-shoulder advance of the infantry in line, with reserves in echelon to protect the flanks. Though eminently suited both to a good development of fire and to meet an enveloping attack, such a formation presents a fine target to hostile marksmen. Still it is something of a problem to devise a means of meeting a savage marksman, supported by artillery, an enemy who charges with reckless boldness covered

Digitized by Google

by fire, either his own or that of his friends, and who, while almost your equal with the rifle, is far your superior in a hand-to-hand fight. The Regulars cannot always fight on their own ground or in entrenchments, so that some tactical formation to meet the above requirements is necessary.

That the Abyssinians, and Menelik himself in particular, were entirely underestimated by the Italians is obvious from the whole story of both the negotiations and the operations. Such a fault however is not peculiar to the Italians, though its results in their case were perhaps more strikingly disastrous than in others.

In conclusion, the contrast between the various Italian operations against the Abyssinians and the Dervishes, brings out well the marked inferiority of the latter. In the study of British successes in the Sudan let us not condemn too lightly the failure of others.

I venture to think that in the study of such failure, more is to be learnt than from the perusal of successful campaigns, in which the difficulty lies in properly appreciating the exertions by which the war machine was made to run so smoothly.

Digitized by Google

# *TERRITORIAL FIELD COMPANIES, ROYAL ENGINEERS.*

*By* MAJOR F. E. G. SKEY, R.E.

FEW branches of the Service can boast of more honourable duties than can the Engineers of the present time, by the light of the experience gained in South Africa and Manchuria; for not only have they still to maintain the character for technical skill and enterprise which they have inherited from many generations of their predecessors, but they also now possess new and very important duties in the field of battle, and especially in the attack, which have added very considerably to their responsibilities. As partakers in these duties and responsibilities, all members of our Corps will cordially welcome the newly raised Territorial units.

In the *R.E. Journal* for December, 1908, Capt. J. H. Robinson, R.E. (T.), has asked for the views of officers as to the best mode of organizing and training a Territorial field company, and the following suggestions are offered in compliance with this request.

It is probable that in the matter of technical skill the Territorial units of the Corps will prove superior to their Regular brethren. The large and valuable class of skilled mechanics, of which the country is so justly proud, supplies, as is only natural, but few recruits to the Regular Army. And yet it must undoubtedly contain many men who, from a love of manly occupations and the honourable desire to take a part if required in the defence of their homes, would willingly spend part of their leisure in military training, and to these men Engineer units might be expected to offer a more congenial field of occupation than other branches of the service. With this class taking service freely in their ranks, the Territorial companies, in *personnel*, would have a great advantage over the Regulars.

It is suggested that it would be unwise to lay down very strict rules as to the details of trades. Each section should have a minimum of ordinary trades, but the majority might depend on the peculiar conditions which exist in its special district. Thus a section, half-company, or even a whole company, may draw its members from some large engineering or mining works, and such a company, or part of one, should be encouraged to pride itself on its special craft, even to the extent of bearing a nickname calling attention to the fact, which would be known throughout its division. It is not hard to imagine contingencies in civilized warfare, where a general would have

Digitized by Google

reason to congratulate himself if he found in his command a company of men used to building up girder bridges, or to work with corrugated iron, or at heavy earthwork, roadmaking, quarrying, or mining. In addition to this, it would be well if young men under training as civil engineers could be induced to join the ranks, with a view to rising through the non-commissioned ranks to eventual commissions. Such men would aid the officers by a solid backing of intellectual skill, which would go far towards raising the technical standard of the Corps generally.

In an even greater degree should these considerations count in the selection of the officers. Engineering qualifications should be a *sine qua non* for all Engineer officers, and the more highly qualified men who can be induced to support the Territorial branches of the Corps, either by actual service or at any rate by their cordial interest, the better. If they cannot serve they might at least associate themselves with the different units in various ways, such as patronizing lectures which may be arranged for their instruction, and taking part in the subsequent discussions.

An additional advantage to be gained by thus attracting the heads of the civil profession to take interest in the military branches is that it is a well-known lesson of history, and not the least of the principles of the great Napoleon, that all fresh science should be drawn into the service of war. If, through the Territorials, men of science can be attracted to an interest in military matters, much advantage to the State would undoubtedly accrue.

As regards the equipment of the Territorial field companies, that of the Regular units should of course serve as a guide. But the bridging equipment might with advantage be discarded, partly because it adds a quite embarrassing bulk to the train of a small and otherwise compact unit, and partly because in a civilized country, field companies should be able to improvise with planks and barrels, or such-like stores, rafts or bridges the necessity for which can easily be foreseen.

As to bicycles, the more men who can be equipped with this useful form of conveyance the better, for everything should be done on service to husband the strength of the men and bring them to their destination fresh and ready for any heavy work which may be found for them. An elementary knowledge of equitation among the men would not come amiss, and among the officers a good knowledge is essential. The driving and repairing of motor cars is a useful knowledge in modern times.

Having now collected our Territorial unit, with its high standard of intelligence, both natural and technical, we will proceed to discuss the lines which might be followed in its limited opportunities for military training. For the majority of the men this training will fall roughly under two headings, dependent chiefly on the season of the year, namely, practical and theoretical.

Digitized by Google

It is suggested that a large proportion of the practical training should consist of purely military training. The men must learn to march, and to understand march and camp discipline as well as, if not better than, infantry, for they must not only keep their place in column, but must be prepared to work at any time before, after, or during a march. Next, they must be able to shoot, and their skill at skirmishing and moving over country must be practically as good as that of infantry. This last is a most important accomplishment, and one on which their whole success in clearing the line of approach for an assaulting column, or in obtaining accurate information on the state of the hostile defences, may depend. Furthermore, each Sapper must be prepared to carry with him some tool in addition to his rifle, and which of the two, tool or rifle, is carried, and which is slung, must depend on the practical requirements of the work in hand. As a part of the field training, the general soldierly habit of scouting, seeing without exposing oneself and gaining information without giving any away, should be trained and encouraged in every way; and, as engineers, the men should be taught to notice and collect information about natural objects and the resources of the neighbourhood in which they are operating, which might be technically useful to them in any emergency.

As regards military engineering, ordinary trenchwork is nowadays an essential part of infantry training, and the Sapper should be able to do something rather better, traversed, with head cover, and carefully concealed. Simple obstacles should be learnt, and to some extent the preparation of casemated cover, but the main instruction in this subject might be given by means of full-sized models, which should be made as practical as possible, especial attention being paid to irregularity in outline and concealment.

In bridging, the men should learn knotting and lashings, with trestle bridging and the preparation of barrel piers. One or two of the simplest expedients, such as floating a wagon in a tarpaulin, might be taught should opportunity offer, and much advantage would be gained by varying materials in the work already mentioned, substituting wire for rope lashings, or squared timber for round, or small barrels for large ones. The great object is to make the men handy and ingenious in the use of available materials. The building of crows' nests in trees is another useful service, which will be much required in future wars. The making of fascines might also be taught, they are useful in many ways.

To the above list must be added instruction in the use of the explosives carried in the equipment, with their application to various kinds of demolitions, and the erection and working of the water-supply equipment. A knowledge of semaphore signalling would also be useful to all ranks, and could be practised as a kind of "stand easy" in intervals between more fatiguing exercises.

Digitized by Google

The above remarks apply to the sappers only—the drivers should of course be taught riding, driving, and the care of horses in stables and on the picket line—and while the whole list might be tackled in peace, there should be no additions to it in view of the contemplated period of six months' training which is assigned in theory to Territorial units on the outbreak of war. The perfecting of the instruction contained in this list would give abundant employment for the early days of the course, and, besides this, at such a time Engineers are in great request, provisional works may have to be put in hand for the defence of various important localities, and this period of training may take a practical turn which may not now be contemplated by the authorities.

As regards the theoretical instruction, it is suggested that the best form for this would be weekly lectures during the winter months, forming entertainments of the free-and-easy, smoking type, which are always popular. The lectures should be short, each dealing with some branch of training, and discussions should be encouraged. Historical incidents relating to the work of the military engineer should also find a place among these lectures, and no efforts should be spared to make them interesting. There might at first be some difficulty in finding lecturers, but the demand would soon secure the supply, of which the chief source would be the officers and non-commissioned officers who may have attended courses at Chatham and at other schools of instruction.

In conclusion, much good might possibly result if the field companies belonging to certain divisions of the Regular Army were associated with those of certain divisions of the Territorials. These units might be encouraged to take mutual interest in one another's work and play, programmes of coming events might be exchanged, and possibly it might even be arranged for the Regulars to lend assistant instructors to the Territorial camp, and the Territorials to send men under instruction to their associated companies on manœuvres and such-like occasions. Interchange of thought by means of correspondence, and possibly also interchange of lecturers, might prove interesting and advantageous to both units, and the mutual knowledge and sympathy thus engendered could not fail to assist in binding together the various branches of our Corps to the advantage of all concerned.

Digitized by Google

# *TERRITORIALS OF THE 1ST CENTURY, B.C.*

*By* COLONEL O. E. RUCK, LATE R.E.

IN the *R.E. Journal* for November, 1908, records from official correspondence, dated Gravesend, 1780, are quoted, describing how certain Volunteer Bargemen were rapidly trained to perform artillery duties on the Thames Defences, thus showing that the principle of employing economical civilian substitutes for Regular soldiers had been already thought out there.

Unfortunately these records omit to make mention of the closing of this experimental transaction, by the bestowal of any "Pecuniary Gratification" being awarded to those "efficients" of these Bargemen-Artillerists, each and all of whom, after six weeks' training on the 27th April, 1780, had been inspected and reported on as smart and good-humoured experts in the art of great gun exercises.

Those of our latter-day savants, who enjoy the time and inclination to delve into the works of some of the comparatively early writers, will find a rare treat in the large amount of carefully detailed matter, descriptive of the organization and administration of the Territorial troops and auxiliaries of the Roman Empire.

Pay, food, clothing, and equipment are minutely described therein, as well as the corellation of these ready-to-hand troops with the Regular Roman Army.

About the time of the 1st century, B.C., various outlying Territorial provinces and states were admitted to the rights and privileges hitherto enjoyed by the Roman citizens only; amongst these was included the *Jus Militiæ*, or the right to take up arms when called upon in attack or defence by the Roman Empire.[1]

The Territorials then furnished at least an equal number of infantry with the Romans, and double the number of cavalry, sometimes more.[2] Moreover these troops were paid and clothed at the expense of their own states.[3] They received nothing from the Roman Army Head-quarters but a ration of corn, by reason of which they had their own Territorial paymasters, or Quæstors.[4] The troops supplied by the outside states were called *Auxiliaries Milites*, each district having to furnish, when required, a certain number of men, in proportion to its extent, population, and opulence.[5]

[1] Zosim., IV., 30, 31. [2] Livy, VIII., 8, XXII., 36. [3] Livy, XXVII., 9. [4] Polybius, 6. [5] Cicero, Att., VI., 5, Varr. and Fest.

Digitized by Google

The question of "Pecuniary Gratification," or personal pay, appears to have been at first a matter of quite secondary importance; originally there was no pay, every Regular soldier serving at his own private expense, pay being first given about 300 B.C. The pay in the times of the Republics was two eboli or three asses (about 2½d. English) a day to a foot soldier, subject to the usual stoppages for uniform and a deduction for his daily ration (*dimensum*) of corn at 4 bushels per mensem. Julius Cæsar doubled the pay to 5d., Augustus raised it to 7½d. per diem, but Domitian increased it still more by adding an annual bonus of three small gold pieces per head.[1]

In its palmy days no cooks were provided in the army, each man cooking and dressing his own victuals. Two meals a day were partaken of; a stand-up dinner of a light description, and a sit-down supper of a slightly more indulgent nature. Poska, or water mixed with a modicum of vinegar, was the customary drink indulged in by all.[2] Sometimes, on an occasion of special bravery, a soldier received as a reward a double issue of corn (*duplex frumentum*), which he was permitted to share with a friend.[3]

The load which a Territorial, if called up for service, would have to carry was by no means a light one.[4] Rations (corn) for 15 days,[5] sometimes more,[6] usually corn, sometimes dressed food (*coctus cibus*),[7] *utensilaria*, one saw, one basket, one mattock (*rutrum*), one axe, one billhook and leathern thong, one chain, one pot, etc.,[8] stakes, usually 3 or 4, sometimes as many as 12,[9] the whole figuring up to a grand total of 60 lbs. weight, exclusive of arms, which weapons the Roman legionary is supposed to have looked on, not in the light of a burden, but as a visible and integral part of his own personal self.[10] Under this load, from continuous training, the soldier marched 20 miles a day, sometimes more.[11]

The form of oath for the Territorial differed; before assembly the *Sacramentum*, a voluntary oath to obey their commander and not to desert the standards, was taken.[12] No man was permitted to enrol his name under the age of 17, but it is reported by Livy, XXV., 5, that in order to be legally fit to fight the common enemy, many youths under that age had taken the oath as a Territorial. After embodiment the military oath, or *Jusjurandum*, exacted by the military tribunes, in which the name of the Emperor was inserted, was taken. This oath was renewable on each anniversary of the soldier's birthday, and always on the occurrence of a mutiny.

[1] Domitian, 7, Suetonius. [2] Plaut., Mil., III., 2, 23. [3] Livy, II., 59. [4] Virgil, G., III., 346; Horat., Sat., II., 2, 10. [5] Cicero, Tusc., II., 15. [6] Livy, Epit., 57. [7] Livy, III. [8] Livy, XXVII., 45; Horat., Epod., IX., 13. [9] Livy, III., 27. [10] Cicero, Tusc., II., 16. [11] Vegetius, I., 10; Spartian, Adrian, 10. [12] Livy, III., 20.

Digitized by Google

# *LIME AND CEMENT MIXTURES.*

*By* MAJOR A. H. D. RIACH, R.E.

THE engineering and building journals have, of recent years, contained many references to the practice of adding lime to cement mortars, or, in the case of cheaper work, of adding cement to lime mortars. The advantages in the former case are that the colloidal lime makes the cement mortar of a fatter consistency and therefore more workable, and also that the lime particles fill the interstices which exist between the particles of sand and cement, and so cause the mortar to be less porous. In the latter case the addition of cement to a mortar of fat, or feebly hydraulic, lime expedites the initial setting of the mass, presumably by quickening the process of crystallization, which is the essence of all setting of mortars, it being suggested that each particle of cement, setting rapidly, forms a nucleus about which the insoluble crystals of carbonate or silico-aluminates of lime can readily arrange themselves.

Many engineers are averse to the idea of combining two materials which require different treatment, but while the writer has seen no arguments to show that the principle is unsound, both practice and laboratory tests go to prove that the benefits claimed can be realized, and further, that better results can be thus obtained at a less or, at all events, no greater cost.

Some again have gone further by substituting certain kinds of earthy matter for lime as a material to fill the cavities and obtain denser cement mortars. To those who have been trained to believe that all sand and ballast must be scrupulously freed from all mud if the best results are to be achieved this will sound a dangerous doctrine, but here again the testing machine and the finished work can be called in to testify to the fact that there is much to be learned in this direction.

The chemist can perhaps explain the apparent contradiction, but it certainly appears from personal observation that while certain qualities of clay or mud kill the cement, those of another chemical composition do no harm, and may even be beneficial. The distinction suggested is that all earths of an argillaceous nature, such as might be used for the manufacture of cement or for brick-moulding, unless calcined, are injurious to cement, and must be washed out of the sand and aggregate, but that the same earths after calcination, and also those which, while making a slimy mud, are of no use for brick

Digitized by Google

burning, are harmless, and in some instances advantageous, if present in cement mortars up to a limited proportion.

A better understanding of the subject is very desirable; perhaps some reader will supply a fuller explanation. Meanwhile the following notes taken from recent periodicals may be of interest.

In *The Engineer* of 6th September, 1907, Mr. Challoner advocates the use of lime, trass, and sand mortar in place of low grade cement mortars, when time can be given for the strength to develop. Starting with a sharp sand, with grains well graded so as to lie compactly, with a volume of interstices equal to 40 per cent. of the total volume, he argues that cement mortars of less than 1 cement to $2\frac{1}{2}$ sand (by volume) are not dense (mortars he describes as dense when the proportion of the volume of the binding materials to that of the hollows is greater than unity, and *vice versâ*). Mortar which is not dense is porous and absorbent. He finds that the addition of trass to cement mortars makes them dense, *e.g.*, 1 cement, 1 trass, and $4\frac{1}{2}$ sand is equal in density to 1 cement, 2 sand, and as regards strength, after three months, is nearly equal to 1 cement, 3 sand. Again 1 cement, 1 trass, and 4 sand is stronger, after three months, than 1 cement, 2 sand. Moreover mortars of trass and cement continue to increase in strength after one year, which is not the case with cement and sand mortars ordinarily.

He then describes the results of tests of mortars of trass, lime, and sand, which show as follows :—

At 28 days old and upwards :—

1 trass, 2 lime, 5 sand is stronger than 1 cement, 5 sand, and more than twice as dense.

1 „ 1 „ 2 „ is stronger than 1 cement, 4 sand, and nearly three times as dense.

1 „ 1 „ 1 „ is nearly as strong as 1 cement, 3 sand, and more than four times as dense.

$1\frac{1}{2}$ „ 1 „ 1 „ is nearly as strong as 1 cement, 3 sand, and more than five times as dense.

Mortars all machine ground.

Mr. Challoner further points out the need for the aggregate for concrete to be graded, like the sand for the mortar, so as to reduce interstices. If it is not to be water resisting, the concrete need not necessarily be dense, but mortar should always be so, that is, use good mortar rather than a larger quantity of a poorer mortar.

The addition of trass* is said to prevent much of the interior

* Trass is one of the substances known under the general name of Pozzuolana; these are clayey earths, usually naturally calcined by volcanic action, which when added to fat limes confer on them hydraulic properties; "surkhi," or calcined brick earth, is employed in the same way in India, while in China a natural earth is employed for the same purpose.

Digitized by Google

movement of masses of wet concrete, so that fewer hair cracks result. Also the use of trass in cement mortar makes it fat, and saves labour in laying.

*The Architect* of September 25th, 1908, prints a Paper on "Hydrated Lime and Cement Mortars," read before the American Society for Testing Materials, by E. W. Lazell, Ph. D., Chemical Engineer, Philadelphia. This Paper demonstrates that mortars made of suitable mixtures of dry hydrated lime, cement, and sand are better in many respects than richer (and more costly) mixtures of cement and sand. (The hydrated lime referred to is fine lime powder prepared from freshly-slaked quicklime, of a fat nature such as might be used for making lime paste for ceilings and fine lime plaster). Cement mortars are short, that is they do not spread easily under the trowel, but have great strength and develop this strength quickly, and it is found that the addition of lime makes them work smoothly. Also, the lime being bulky as compared with cement, its addition considerably increases the volume of the mortar.

A series of tests to ascertain the best proportions to use, show that briquettes of a mortar of 0·85 cement, 0·15 lime, and 3 sand are as strong at all lengths of time up to 12 months as those of 1 cement to 3 sand; also that with 0·6 cement, 0·4 lime, and 5 sand the tensile strength compares favourably with 1 cement and 5 sand.

The lime-cement mortars, being plastic, can be far more easily worked than cement-sand mortars.

These results were obtained from briquettes stored in air and moistened once a week.

To demonstrate the effect on the lime-cement of water, a series of briquettes were kept in water, after three days in air, and it was found that considerable additions of hydrated lime to the cement mortars caused only a small reduction in tensile strength when setting took place under water, as compared with cement-sand mortars, and also that lime-cement mortars are more impervious to water than those without lime. This latter characteristic was conclusively proved by a series of percolation tests; for instance, while pats of mortar of 1 cement to 5 sand allowed 3,000 c.c. and 1,090 c.c. of water to pass through per hour, after 28 and 42 days respectively, similarly treated pats of 0·85 cement, 0·15 lime, and 5 sand showed no measurable percolation. The inference as stated by the author is as under:—

"The tests would indicate that in hydrated lime we have a suitable material to add to cement mortars to render them plastic, thus increasing the sand-carrying capacity and the ease of working without materially reducing the strength; 1:5 mixtures containing an amount of hydrated lime equivalent to 35 per cent. of the cement used are amply strong for all purposes, and are practically impermeable to water. These mortars should also increase in strength, if exposed to

Digitized by Google

air, through the absorption of carbon dioxide, as is the well-known case with lime mortars.

"It would therefore seem to be advisable for architects, engineers, and builders to give this material careful consideration in view of its many desirable characteristics."

The two articles cited above serve to show the trend of opinion and the diversity of practice, and suggest means of obtaining a more water-tight and workable mortar, without sacrifice of strength or increase of cost, which will be of the greatest service, especially to those working in reinforced concrete, when impermeability is desirable, or when a rendered or moulded surface is required.

If engineers generally, throughout the world, would communicate to the technical papers the results of their efforts to thus usefully combine the materials at their disposal, the somewhat nebulous theories now held would soon be established on the substantial foundation of observed practical results.

Digitized by Google

# *THE R.E. HEADQUARTER MESS.*

(*Continued*).

*By* LIEUT.-COLONEL B. R. WARD, R.E.

Grouped round the full-length picture of Sir Charles Pasley are smaller portraits of the following officers:—General Sir Henry Harness, Colonel C. C. Chesney, General Sir Lothian Nicholson, and Lieut.-General Sir Gerald Graham.

General Sir Henry Drury Harness, K.C.B.* (1804—1883), was gazetted Second Lieutenant in the Corps in 1827. His only war service was in the Mutiny, where he acted as C.R.E. under Lord Clyde at the Siege and Capture of Lucknow, and in the subsequent operations in Rohilcund and Oudh. He was however a most able administrator, and held many civil appointments of great prominence and responsibility. From 1846 to 1850 he was Secretary to the Railway Commission at a time when railways were beginning to develop with startling rapidity; from 1850 to 1852 he was Deputy Master of the Mint, and from 1852 to 1854 he was Commissioner of Public Works in Ireland.

The work however for which he will always be best remembered in the Corps, was his reorganization of the Engineering School at Chatham during the years 1860 to 1865.

"No man," writes General Collinson in the *R.E. Journal* for 1883, p. 86, "could have been more fitted to carry out such a matter than Harness. The vigour and the grasp of his mind and his knowledge of the different branches of work, enabled him to map out the principles on which such a school should be conducted, and the general scheme for each branch of the practical education of a Military Engineer; while his personal character and his established influence in the Corps stamped all his proposals with an authority that carried them through with ease and rapidity. Loyal to the revered founder, whose pupil he himself had been, the great idea on which it was all based was carefully preserved; namely, that the education of the Corps in military science was as much a Corps duty as its military drill; and therefore that it should be carried on by the senior officers teaching the juniors, and by the non-commissioned officers teaching the recruits. So that officers and men, working and learning together on the same class of work, would commence their career with the feeling that, however varied their duties and scattered

* *Dictionary of National Biography*, Vol. XXIV., p. 414.

Digitized by Google

their individuals over the world, they are one united body, who, officers and men together, have the duty of applying all branches of science to the defence of the country. Harness's ambition for the Corps was that the officers should be acquainted with the principles of all physical sciences, so that the Government might feel that they had in them a body of advisers they could depend upon in all such matters, and in the men a body of trained artificers, equally to be depended upon for carrying out any such work on an emergency."

After leaving Chatham he was put on the Council for Military Education, and later on he became a member of the Defence Committee under the presidency of Sir Harry Jones. His last appointment was that of president of a temporary Government department instituted to take measures to combat the cattle plague which broke out with great virulence in 1866.

A man possessing great administrative ability and charm of manner, his influence over his contemporaries was very great, as can be seen from General Collinson's Memoir and from the *Life and Letters* published by the R.E. Institute in 1903.

Colonel Charles Cornwallis Chesney* (1826—1876) made his reputation as a military essayist. Many have since followed up the line he first struck out for himself when, as a Captain and Professor of Military History at the Royal Military College, in 1863, he published a volume entitled *A Military View of Recent Campaigns in Virginia and Maryland.* The series of essays published in this volume gave a new impetus and direction to the scientific study of war. In the hands of men like the late Colonel G. F. R. Henderson, Chesney's method has been still further developed and utilized as a means of military instruction. Chesney however may fairly claim to be a pioneer in this work. In 1864 he was appointed Professor of Military History at the Staff College, and brought out a second volume entitled *Campaigns in Virginia, Maryland, etc.*, continuing the history to the end of the third year of the war, when Grant was made commander-in-chief of the Federal forces.

General Lee, the great Confederate commander, who died in 1870, read Chesney's volumes soon after the war, and commented on them as follows :—"It is a remarkable fact that the best history of the war that has yet appeared has been written by an English officer, who must have got all his information from our opponents."

Chesney's *Waterloo Lectures* (1868) and his *Essays in Military Biography* (1874) form a brilliant continuation to his *Campaigns in Virginia*, but it would be difficult to add to the reputation of a military author with a criticism to his credit, such as the one quoted above, from the lips of "the greatest general who ever spoke the English tongue."

General Sir Lothian Nicholson,† K.C.B. (1827—1893), was gazetted

* *Dictionary of National Biography*, Vol. X., p. 195.
† *Dictionary of National Biography*, Vol. XLI., p. 21.

Digitized by Google

Second Lieutenant in 1846. He commanded the 4th Company of the Royal Sappers and Miners during the last month of the Siege of Sebastopol, and subsequently commanded the same company as the 4th Company, Royal Engineers, during the Indian Mutiny. Possessing a good constitution, and being full of energy, he did excellent work throughout the latter campaign, being five times mentioned in despatches by Lord Clyde, Sir James Outram, and Sir Hope Grant. He was rewarded by a Brevet Lieutenant-Colonelcy in 1858, and was awarded a C.B. in the following year.

In 1877 he was promoted Major-General, and in 1878 he was appointed Lieutenant-Governor of Jersey. In 1881 he was promoted Lieutenant-General, and in 1886 he succeeded Sir Andrew Clarke as Inspector-General of Fortifications. In 1887 he was made a K.C.B. In 1891 he was made Governor of Gibraltar, where he died, after a short illness, in 1893.

Lieut.-General Sir Gerald Graham,* V.C., G.C.B. (1831—1899), obtained his first commission in 1850. During his 40 years' service he maintained a reputation for courage and coolness in action that has probably never been surpassed. He was one of those rare individuals in whose make-up the element of fear seems to be totally wanting. It was therefore in accordance with the fitness of things, that at the inaugural ceremony, celebrating the institution of the Victoria Cross, Gerald Graham should have been one of the recipients of the coveted decoration. The Queen had instituted the new distinction by a Royal Warrant of the 29th January, 1856, and on the 26th June, 1857, the inaugural ceremony took place in Hyde Park. Sixty-two officers, warrant officers, non-commissioned officers and men were on that day personally decorated by the Queen.

Graham's cross was given for "determined gallantry at the head of a ladder party at the assault of the Redan on the 18th June, 1855, and for devoted heroism in sallying out of the trenches on numerous occasions and bringing in wounded officers and men."

In a letter to his father he describes the ceremony as follows:—"We were formed in line, and then advanced singly to the Queen, who remained on horseback. She pinned on the cross with her own hand to our coats. She stuck the pin fairly into me, so that I keenly realized my momentary interview with Royalty."†

In after years, when Graham commanded a brigade in the Egyptian Campaign of 1882, and later on in 1885, when he was in command at Suakim, the quality of personal courage was still his most prominent characteristic. Lord Wolseley constantly refers to it in his despatches.

In an article entitled "Courage," contributed by Lord Wolseley to the *Fortnightly Review* of August, 1888, he mentions five men of his

* *Dictionary of National Biography*, Supplement, Vol. II., p. 334.

† *Life, Letters, and Diaries of Lieut.-General Sir Gerald Graham, V.C., G.C.B., R.E.*, by Colonel R. H. Vetch, C.B., 1901, p. 139.

Digitized by Google

acquaintance in whom this quality was pre-eminent. Three of the five are represented in our Mess Portrait Gallery—Graham and the two Gordons. The following is his reference to Gerald Graham :—

I have heard it said that small men are generally braver than tall men, but one of the most stolidly and immovably brave men I have ever known is several inches over 6 feet in height. I have often seen him, from pure laziness, when relieved from duty in the advanced trenches before Sebastopol, step out calmly in rear of the parallel where he happened at the moment to be, and take a bee-line for camp, exposed for many hundred yards to a heavy rifle fire from the advanced works of the Russians. He might have walked home through the trenches in safety, but he was too lazy or too careless of his life to go so far round. I remember a curious instance of his imperturbability some years afterwards, when I met him in China. In the assault of the Taku forts we had to cross two ditches filled with water. One of these was sufficiently wide and deep to require a bridge to be thrown over it. In carrying up a light-infantry pontoon bridge to launch into this ditch, a round shot went through one of the pontoons. To launch it in that condition would have caused it to sink, and we had great difficulty in getting the injured pontoon out of the bridge under the close, severe fire to which we were exposed from the works behind the ditch. In common with all the other mounted officers, I had left my horse at a safe distance behind under some cover. I was therefore astonished when, upon standing up after working at this little bridge on the ground, to see beside me a very tall man on a very tall horse. The position was actually comical, and as well as I remember, I laughed as I saw my cool friend there at the edge of the ditch, a regular cockshot for every Chinaman near him. He said something to me which, owing to the great din and noise at the moment, I could not hear, so moving nearer to him I carelessly put my hand on his leg. He winced a little as I touched him, and calmly saying "Don't put your hand on my leg, for I have just had a bullet in there," went on with his conversation as if only a mosquito had bitten him. That man is now known to all as Lieut.-General Sir Gerald Graham, V.C., who commanded a brigade at Tel-el-Kebir, and who was afterwards in chief command at El-Teb and the many other bloody engagements which took place near Suakim.

At the Annual Corps Meeting held on the 5th June, 1884, it was decided that Graham's portrait should be painted. The portrait, which represents him in the red service dress of the period, was painted in 1886 by Sir E. Poynter—now President of the Royal Academy.

In the recess at the west end of the Mess Room hangs the portraits of the Duke of Wellington and of General Sir James Browne, K.C.B., K.C.S.I. In point of artistic merit neither portrait is at all commensurate with the fame either of the Iron Duke or of "Buster Browne."

As already pointed out in last year's February number of the

Digitized by Google

*R.E. Journal*, the Duke of Wellington's urgent representations as to the necessity for trained Sappers were the immediate cause of the Royal Warrant of the 23rd April, 1812, authorizing the formation of the R.E. Establishment at Chatham. In Gurwood's *Despatches of the Duke of Wellington*, edition of 1837, Vol. IX., p. 49, is a letter from General the Earl of Wellington, K.B., to Lieut.-Colonel Torrens, Military Secretary to H.R.H. the Commander-in-Chief, dated Camp at Badajoz, 7th April, 1812. The letter opens and closes with the following sentences :—

"My dear Torrens,

"I send by this occasion the accounts of our success before Badajoz. * * * * Our loss has been very great; but I send you a letter to Lord Liverpool which accounts for it. The truth is that, equipped as we are, the British Army is not capable of carrying on a regular siege.

"Believe me, etc.

"WELLINGTON."

In a note on the same page Gurwood writes: "A search, hitherto unsuccessful, is being made for this letter. From the *précis* of it in the Index of 1812, as well as from documents in the Ordnance Office, it appears that this letter recommended the formation of a Corps of Sappers and Miners, the want of such an establishment with the army being the chief cause of the great loss in the sieges."

For 77 years this letter remained hidden amongst the Earl of Liverpool's papers. In 1889 Mr. C. Leeson Prince, of The Observatory, Crowborough, Sussex, found the missing letter tied up with others of a very unimportant character. The letter was first published in the *Athenæum* of the last week in April, and was subsequently reprinted in the *R.E. Journal* of the 1st June, 1889, Vol. XIX., p. 132. The letter runs as follows :—

"Camp at Badajoz, April 7, 1812.

"My Dear Lord,—My despatches of this date will convey the account of the capture of Badajoz, which affords as strong an instance of the gallantry of our troops as has ever been displayed. But I anxiously hope I shall never again be the instrument of putting them to such a test as that to which they were put last night. I assure your lordship that it is quite impossible to expect to carry fortified places by *vive force* without incurring great loss, and being exposed to the chance of failure, unless the army should be provided with a regular trained corps of sappers and miners. I never yet knew a head of a military establishment or of an army undertaking a siege without the aid of such a corps, excepting the British army. There is a body of sappers and miners attached to every French corps; and each of the armies in the East Indies has one; and every army in the world except ourselves. The consequence of being so unprovided with the people necessary to approach a regularly fortified place are—first, that our engineers, although well educated and brave, have never turned their minds to the mode of conducting a regular siege,

Digitized by Google

as it is useless to think of that which it is impossible in our service to perform. They think they have done their duty when they construct a battery, with a secure communication to it, which can make a breach in the wall of a place; and, secondly, these breaches are to be carried by *vive force* by an infinite sacrifice of officers and soldiers. To this add that storming a breach, or attacking a place by escalade, is an operation of a very different description from fighting a general action. In the latter every man, generally speaking, has an equal chance; but in the former the officers, the bravest and best of the non-commissioned officers and soldiers, go first. The loss falls upon these; and five minutes after the breach is carried women and children might enter it instead of men. You see in the attack of Badajoz we had six out of seven general officers employed, all their staff, and a very large proportion of the officers killed or wounded. In the attack of the *Picurina* it was the same, and we lost 200 out of 500 men employed. These great losses would be avoided, and, in my opinion, time gained in every siege, if we had the properly-trained people to carry it on. I declare that I have never seen these breaches more practicable in themselves than the three in the walls of Badajoz; and the fort must have surrendered with these breaches open if I had been able to approach the place. But when I had made the third breach on the evening of the 6th I could do no more. I was obliged then to storm or give the business up; and when I ordered the assault I was certain that I should lose our best officers and men. It is a cruel situation for any person to be placed in, and I earnestly recommend to your lordship to have a corps of sappers and miners formed without loss of time.

"Believe me, my dear lord,

"Ever yours most sincerely,

"WELLINGTON."

It is interesting to note that the Duke's letter is dated 7th April, the Royal Warrant authorizing the R.E. Establishment at Chatham being dated the 23rd of the same month. Cause and effect are seldom so closely related!

The life of General Sir James Browne, K.C.B., K.C.S.I. (1839—1896), has been recorded by Lieut.-General J. J. McLeod Innes, V.C. It was a life well worth recording, both on account of what he did and also on account of what he was. It is hard to decide whether his deeds or his personality were the more remarkable.

His great engineering feat was the construction of the Harnai, or Sind-Peshin, railway from 1883 to 1887.

As a soldier it was no small triumph to have been selected by Lord Roberts in 1889 for the post of Quartermaster-General in India.

As an administrator he made his mark from 1892 until his death four years later in the arduous and responsible position of Agent to the Governor-General in Beluchistan.

Colonel G. K. Scott-Moncrieff, who was his Personal Assistant during the construction of the Harnai railway, wrote a review of

Digitized by Google

General Innes' biography in the *R.E. Journal* for 1905, Vol. I., p. 356, from which the following extracts are taken :—

Among the many distinguished men who left Addiscombe to join the Indian Engineers, amalgamated in 1861 with the Corps of Royal Engineers, probably there has been none of such varied attainments as the subject of this memoir. There have been great soldiers like Lord Napier of Magdala, great engineers like Sir Arthur Cotton, and great administrators like Sir Henry Durand; but Sir James Browne was distinguished in all three branches. He was, moreover, a man of marked scientific attainments, a linguist of wide range, a mathematician of no ordinary calibre, a wise and far-seeing statesman. When we add to the above that nature had endowed him with a herculean frame, a rich and sonorous voice and good ear for music, and a peculiar power of attracting the regard and affection of his fellow men, it will be admitted that his biographer has indeed a difficult task to perform in presenting an adequate picture of so varied a character from the *embarras de richesse* of the subject.

As a subaltern Browne did good work in the Mahsud Waziri Campaign of 1860 and the Umbela Campaign of 1863.

As Executive Engineer, first of the Kohat and then of the Kangra Divisions on the frontier,

the bridges he designed and built were of every variety, and some indeed are among the finest specimens of the art of the *pontifex maximus* that are to be seen anywhere. Stone bridges of a greater span than 140′ are, indeed, to be found in other parts of the world; but Browne is, so far as we know, the only engineer who has built bridges of that span with bricks burnt in his own kilns,—a bold feat for a sapper subaltern! It was no mere guess work. Every step he took was founded on thorough mathematical investigation coupled with careful practical experiment, and, as he often told the writer, each successful step he thus took gave him fresh confidence for other and further designs. He delighted in scientific engineering, it was to him a charming combination of mind and matter, a conquest of nature by study of her laws, a subject of infinite variety and infinite expansion. And in this his great mathematical powers were of incalculable value. He had not the mere bowing acquaintance with the calculus that some of us have; he grasped it as a valuable tool, and used it with the skill of a master.

o o o o o

But the greatest work he ever accomplished was the making of the Harnai—or, as it is more correctly called, the Sind-Peshin—railway.

o o o o o

The story of the construction of the Harnai line has already been told in the *Royal Engineers Professional Papers*, in the columns of *Engineering*, and in the *History of the Royal Engineers*, but no words can describe it adequately. Such a record of difficulties from pestering interference from above and pestilence, cholera, scurvy, and fever from below, strikes of work-

Digitized by Google

men, unusual floods and landslips, insufficiency of food and transport—added to the stupendous task of pushing through in 3 years, 165 miles of a railway which combined every natural obstacle with the most trying of climates—such an undertaking few men have had to face and fewer have carried through with success.

Towards the close of the work, when physical and mental energies had been taxed almost beyond endurance, Browne was further worried by carping criticisms in the Press. There was about that time a flood of misrepresentation concerning the officers of the Royal Engineers, and some of the Indian papers took up this question with peculiar virulence. Invidious comparisons were made between the Harnai and Bolan railways, and some of Browne's brother-officers urged him to take notice of these attacks; and although he systematically kept silence, there is no doubt that they annoyed him. Time has vindicated his action with overwhelming force, for, as has already been stated, his work remains as sound as ever.

To-day the traveller whirls in a comfortable first-class carriage over the great bridges and plunges into the tunnels which were then built, and perhaps there is astonishment at the boldness which designed and the skill which executed these works; but only those who took part in the struggle can have any conception of the toil and pains involved, of the courage necessary to persevere, when cholera and scurvy were raging, when nature seemed to gather all her forces against man's puny efforts, and each day seemed to bring forth some new and unexpected difficulty. As one looks back on those times after the lapse of 20 years, one sees in the midst of it all the splendid personality of the Engineer-in-Chief, always cheery, always plucky, always full of resource, a man among ten thousand, towering above his fellows.

An article published by Colonel G. K. Scott-Moncrieff in *Blackwood's Magazine* for May, 1905, gives a better idea of the personality of Sir James Browne than anything in General Innes' book. The book is an appreciation of the man and his work by an older and senior officer. The *Blackwood* article glows with the enthusiasm of a whole-hearted admirer and disciple. Those who have read the article can hardly be surprised that the German Emperor, after reading it, ordered it to be translated into German. "Buster" Browne, indeed, "was grand," as Lord Roberts once tersely put it.

Many officers who worked under Sir James Browne have since made their mark both as soldiers and engineers. Among the more distinguished of these may be mentioned Colonel Sir Buchanan Scott, K.C.I.E., Major-General Sir Ronald Macdonald, C.B., K.C.I.E., and Colonel G. K. Scott-Moncrieff, C.B., C.I.E., all three of whom served with him on the Harnai Railway, and most probably learnt from him there the lessons which have proved of such use to them in their after careers.

Digitized by Google

# *TRANSCRIPTS.*

## THE NEW FOOT-SOLDIER.

THE following article is taken from the *Matin* of the 27th September, and is one which very closely concerns every foot-soldier, dealing as it does with the reduction of the weight which he has to carry:—

The French "piou piou" at present carries 26·4 to 27·35 kilogrammes, *i.e.*, nearly one-half of his weight in the case of a small man (54 kgrs.), or one-third in the case of a large man (80 kilos.). These fractions are excessive when one considers that a horse, which normally weighs 400 kilos., seldom carries 100 kilos., *i.e.*, one-quarter of its own weight.

This abuse of the infantryman's strength and goodwill is a result of campaigns in Africa, but since 1903 the reduction of the pack has been the object of many experiments and the subject of many discussions.

The recent manœuvres of the 9th Division of the Vth Army Corps, under General Millet, who is President of the Infantry Technical Committee, have given complete satisfaction, and have finally vindicated views which have hitherto been held as theoretical. The division was equipped with the new pattern uniform, equipment, tools, and transport, and these had to satisfy two conditions imposed by the French War Office, viz.:—(1) The maximum weight carried per man was not to exceed 20 kilos., and (2) each man was to have at his disposal 200 cartridges and provisions for two days, either on his back or in the 1st line transport. The detail of this new equipment, etc., is as follows:—

*Comparative Table.*

| Detail. | Old Weight in Kilogrs. | | New Weight in Kilogms. |
|---|---|---|---|
| Uniform ... ... ... ... | 6·175 | ... ... ... ... | 5·290 |
| Equipment ... ... ... ... | 3·550 | ... ... ... ... | 3·230 |
| Contents of knapsack ... ... | 7·350 | ... ... ... ... | 3·050 |
| Weapons ... ... ... ... | 4·840 | ... ... ... ... | 4·840 |
| Cartridges (120) ... ... ... | 3·431 | 88 | 2·220 |
| Divers necessaries ... ... ... | 0·300 | ... ... ... ... | 0·900 |
| Common load of food, etc. { From... To ... | 0·750 1·700 | Individual share of food, etc. | 0·150 |
| Weight carried per man. { From... To ... | 26·400 27·350 | ... ... ... ... | 19·980 |

The actual ways of reducing the weights of the items are as follows:—

*Clothing.*—The tunic, a mere ceremonial garment, and the round service jacket used in the field, are both to be discarded in favour of a pea jacket very similar to that worn by the Alpine troops. The great-coat remains, but is shorn of one row of buttons, and weighs 1,500 grammes instead of 2,160. Moreover it is to be provided with a light hood for use in wet weather.

Digitized by Google

*Equipment.*—By the use of tawny-coloured leather it is hoped to be able to devote to instruction or to rest, the many hours hitherto spent in blacking boots and pipeclaying belts. The stiff, square black knapsack is deposed in favour of a soft rectangular one, and 1,100 grammes are thus saved. The contents are to be :—

| | | | |
|---|---|---|---|
| 1 clean shirt | ... | ... | 335 grammes, |
| 1 fatigue cap | ... | ... | 100 „ |
| 1 pair slippers | ... | ... | 600 „ |
| 1 day's provisions | ... | ... | 960 „ |

and finally an aluminium cooking pot, weighing 400 grammes, is slung outside the knapsack. The remaining clothes, packed in the company valise, are carried in the 2nd line transport.

The common enamelled iron mess tins and cooking pots are replaced by individual cooking pots weighing 400 grammes, whilst by making water-bottles in aluminium instead of enamelled iron 4·5 grammes are gained.

*Provisions.*—Instead of carrying both days' food, the soldier carries one, the company 1st line transport the other. Rice and dry haricot beans (which necessitate much cooking) are replaced by more sugar and coffee, whilst the number of bread biscuits has been cut down from 12 to 6. Finally, common boxes of tinned food have been replaced by a tinned ration per man, weighing 250 to 300 grammes.

*Ammunition.*—The reduction from the 120-mm. to 88-mm. cartridges gains 960 grammes, the balance of cartridges from 200 being carried in the company 1st line transport.

*Entrenching Tools.*—Portable tools have been replaced by a single tool per man, which can be used as a spade, shovel, pickaxe, axe, or sickle. The entrenching tools, which are now of the engineer pattern, are to be carried in two special carts per regiment, which follow the 1st line transport of the regiment.

The net result of all this saving of weight is an increase in 1st line transport, and the 1st line transport of a company now is :—

(*a*). 1 light, 2-wheeled cart, carrying one day's food, the men's jackets, arranged by squads in special bags, and the baggage of the company, including that of officers.
(*b*). 1 light, 2-wheeled S.A.A. cart.
(*c*). 1 moving kitchen.

One medical stores cart is allowed per battalion.

The regimental transport consists of :—

(*a*). 1 light, 2-wheeled cart for headquarters baggage.
(*b*). 1 kitchen on wheels.
(*c*). 1 forge.
(*d*). 2 tool carts.

All the vehicles are 2-horsed with the exception of the medical stores cart, which has one horse only.

Thus the total 1st line transport of a regiment, exclusive of spare horses, consists of 45 carts and 89 horses, which, although cumbersome, is absolutely necessary if the men's loads are to be materially lightened.

A. H. SCOTT.

Digitized by Google

# DR. SVEN HEDIN'S EXPEDITION IN TIBET.

*By* MAJOR C. H. D. RYDER, D.S.O., R.E.

Reproduced from the *Geographical Journal*, by permission.

DR. SVEN HEDIN has returned from another two years spent in explorations in Tibet, and as I have had the opportunity of hearing from him a fairly full account of his work, I am sending this Paper, which has been authorized by him, for publication in the *Geographical Journal*.

After a preliminary journey through Persia and Seistan, Sven Hedin arrived in India, and after overcoming rather more than the usual difficulties, left Leh on August 14th, 1906, with the strongest caravan he has ever had: 25 men and 94 ponies and mules, as well as 30 ponies he hired for the first month; of the 94 ponies, only 6 completed the journey. He was accompanied by a babu Robat, who proved of much use in assisting in scientific observations, as well as Mahomed Isa, who acted as caravan bashi; this man had accompanied Younghusband in his travels, and to Lhasa, was with De Rhins when he was murdered, and was with Rawling and myself in 1905. Sven Hedin speaks in the warmest terms of the invaluable services of this man. He also constantly refers to the kindness he received from the Maharaja of Kashmir, the state officials, Sir Frank Younghusband, Capt. Patterson at Leh, and others.

After leaving Leh, Sven Hedin travelled north-east over the Marsimikla, crossed the Karakorum east of Changlung-yogma, traversed Lingshi-tang and Aksai-chin, crossed Deasy's, Rawling's and Wellby's routes; he then kept east and east-north-east, and turned south-east between the routes of Bower and De Rhins. On the heights of the Buka-mangna route 9 mules were lost in one day, but to the south the country became more and more hospitable, with plenty of grass and water. After 83 days they met nomads for the first time; but then their black tents were visible most days, and they were able to buy yaks to replace the ponies they had lost *en route*. They left De Rhins' Ammoniac Lake to the east, and continued straight south to the Bog-tsang-tsanpo, which they followed for a couple of days to get a connection with Sven Hedin's map of 1901. Turning again south-east, they crossed two considerable ranges, from one of which a small portion of the Dangra-yum-tso could be seen to the south. Sven Hedin reached Ngangtse-tso on December 28th, and here he was met by Hladje Tsering, governor of Nak-tsang, who had already stopped him on his previous journey, and who, though at first inclined to stop him, allowed him to continue south-east. With great good fortune, or probably with the instincts of an experienced Tibetan traveller, Sven Hedin hurried on, and, without halting, and making long

Digitized by Google

marches, struck the Tsanpo 50 miles west of Shigatse, and, following down the left bank, crossed the river and reached that town late on the evening of February 9th, 1907. Two days later a lama and official arrived from Devashong; they had received orders to stop Sven Hedin at Ngangtse-tso. Not finding him there, they had followed him to Shigatse; but it was now too late, Sven Hedin had reached that town and accomplished one of the objects of his journey.

The most important geographical discoveries on this journey were (1) the discovery of a very high and complicated mountain system, and (2) south of it the Mu-chu, which joins the Raga-tsanpo; the latter is the smaller of the two, and most of the water which joins the Tsanpo just west of Pindzo-ling comes from the Mu-chu. The discovery of the high mountain system set Sven Hedin thinking, and it very soon struck him that this must be a continuation of the Nien-chen-tang-la range south of Tengri Nor, the highest peak of which I fixed from near Lhasa at 23,900′. The Khalamba-la, on the road from Shigatse to Tengri Nor, is also on this range. Thus was forged the first link in what Sven Hedin regards as his greatest discovery.

Sven Hedin stayed one and a-half months at Shigatse, during which time he made great friends with the Tashi Lama, and constantly visited the Tashi-lunpo monastery. Although so close to Gyantze, he did not think it advisable to visit Capt. O'Connor there, but speaks in the warmest tones of the kindness he received from that officer. After much difficulty he obtained permission to go up the Raga-tsanpo route, and, turning northwards, re-crossed the main range by the Chang-la Pod-la Pass, thus fixing another 50 miles of the range. His next objective was the Dangra-yum-tso, discovered by Nain Singh; but when within two marches, and in sight of the lake, he was stopped by a force from Shan-sa Dzong and forced to go down south to Raga-tasam, but he was able to fix the position of Targo-gangri, Targo-tsanpo, and Sershik-gunpa, all three heard of but not visited by Nain Singh. The Shuru-tso was also discovered, a rather big lake at the northern foot of the main range, another 60 miles of which being also fixed, as the range had to be once more crossed. At Raga-tasam Sven Hedin touched our route for the first time since leaving Shigatse. Dangra-yum-tso is much too big on Nain Singh's map; and his Mun-tso, two small lakes, are situated not south but west of the southern Dangra-yum-tso. The latter lake, and Targo-gangri, which Sven Hedin describes as one of the most magnificent snow-mountains with glaciers he has even seen in Tibet, are both holy, and form the same combination as Mansarowar and Kailas in the west, and Nam-tso and Nien-chen-tang-la in the east. Sershik-gunpo is inhabited by monks of the Pombo (non-orthodox) sect. From Raga Sven Hedin went to Saka-dzong; needless to say, not by the route followed by our party, but round the north side of the beautiful snows of Chamo-uchong. At Saka Mahomed Isa died, to the great grief of Sven Hedin and his followers, and to all those to whom he has been of such assistance in the Tibetan explorations.

Sven Hedin again wished to strike north, but could not get permission

Digitized by Google

to do this, although he sent messengers to Lhasa. He however turned north from Saka Dzong up a western tributary of the Chaktak (called Charta on our maps) Tsanpo, behind the hills north of our route to Tradom. He then kept south of the river, touching our route at Laktsang, and marching up the main branch of the Brahmaputra to its source, which he located accurately and surveyed. In the *R.G.S. Journal*, Vol. 38, p. 146, Nain Singh mentions being in sight of the gigantic glaciers which give rise to the Brahmaputra. On our journey we surveyed, though only roughly, the main branch; but as Sven Hedin was the first to actually follow the main branch to its source, we obtain a survey much more accurate than mine, which was only a distant sketch. Crossing the watershed, which is very low, Sven Hedin proceeded to the Mansarowar Lake, where he spent some weeks making careful soundings. Owing to dangerous gales, it was impossible to sound the Rakas Tal, but both lakes were carefully surveyed. Following down the bed of the old outlet, Sven Hedin found several springs, which probably are underground channels from the lake. There was no sign of these when Rawling and I were there in December; but as the Rakas Tal was then frozen over, doubtless the springs were also frozen. This however proves that the lakes are still connected, though underground, with the Sutlej system. After an interesting circumambulation of the holy peak of Kailas, Sven Hedin managed to get permission to go north, where he discovered the source of the northern or main branch of the Indus, returning *viâ* Yumba-matsen to Gartok.

The gap of 300 miles in his exploration of the main range north of the Tsanpo called Sven Hedin for yet another long journey. All attempts to go north-east from Gartok failing, he decided to make a long *détour* and come into the unexplored country from the north. He gave out that he was going to Khotan, in the meantime arranging for an entirely new caravan, with new men, to be organized at Leh. He met his new caravan at Durguh, and left that place on December 4th, 1907. Several caravans from Yarkand were used, the members of which advised Sven Hedin to wait till the spring. However, although winter had set in, he passed on. At Burtse he discovered that, owing to the stupidity of his headman, only a supply of eight days' corn for the ponies was left. It was not till at the crossing of the Dapsang that he gave orders to turn due east, leaving the Karakorum Pass to the north. On January 11th they camped on the shore of the Aksai-chin Lake. By January 18th a quarter of the caravan ponies had died, and the cold was intense. To improve matters a storm arose, which lasted for weeks; the caravan however pushed forward steadily, but very slowly. On the northern shore of the Shemen-tso they were nearly snowed up, no meat was left, and the ponies shared the men's rice rations. On February 8th the first hunters were met with, after 64 days' loneliness, and they were able to buy sheep, milk, and butter. Here Sven Hedin burnt all his European clothes, and appeared as a Ladkhi; this entailed blacking his face and hands every morning, and forbade washing. Passing the Lemchung-tso, they now entered unknown country. On February 24th

Digitized by Google

three ponies and seven mules only were left, a quarter of the caravan. On the 29th they reached Lumburringmo-tso, where nomads were met with; these men, although at first suspicious of the presence of a European, soon made friends, and sold 12 sheep to carry loads. For several days the storm was so bad that a move was impossible. On March 7th Sven Hedin camped on a river flowing to the south-west, but frozen over.

On March 16th they pitched camp on the Tong-tso, and turned south, leaving the beautiful Gangri Shakang-sham to the east, and crossed two small passes. They here heard that Karma-Pun-tso, the governor of the Bongba province, was near, but they avoided him, and proceeded through a labyrinth of mountains, crossing the Kang-shan-tsanpo, Chaklam-la, Sangchen-chu, Sangchen-la, and Ladung-la. On April 1st Sven Hedin crossed the Satsot-la, and came down to the Chunit-tso, following its western shore for one day. Here a large salt caravan was met with coming from Tabié-tsaka, from whence most of Central and Eastern Tibet obtain their supply of salt. Still keeping straight south, Sven Hedin crossed the Nima-lung-la, and reached the district of Kemar. From here, once more, he was in sight of the range north of the Tsanpo, a beautiful sight of great snow-fields and glaciers. He now turned south-east, having the magnificent Hlunpo-gangri on his right, and for six days followed the big river Buptsang-tsanpo up to the Samye-la, a pass in the main range. It was here that the name Trans-Himalaya struck him as most suitable for this range. Although Tibetan names are obtainable for every conspicuous peak in this range, the Tibetans have no name for the whole range, and I therefore think the name proposed by Sven Hedin should be accepted. Until Sven Hedin has had time to work out his observations and plot his map, it would be advisable to postpone any discussion as to the extension of this range east and west; but Sven Hedin has very thoroughly explored it throughout that region marked "Unexplored" on the R.G.S. map of Tibet, and there is no possible doubt that the range exists, and is the watershed between the Brahmaputra on the south and the lake region on the north.

Sven Hedin now carried out a thorough exploration of the Chaktak (called Charta on our maps) Tsanpo; however, near Raga he was met by Tibetan soldiers, and considered it advisable to reveal himself. He at once became great friends with the Tibetans, who allowed him once more to select his own route. It was arranged that Abdul Karim, his headman, should go with the main caravan *viâ* the Samye-la, to meet him again at the Buptsang-tsanpo, while Sven Hedin himself, accompanied by only five men, left his Saka friends on May 6th, 1908, and went straight north, to what he describes as the most interesting of his crossings of the Trans-Himalaya range.

By the Gyegong-la he crossed the Kanchung-gangri range, which is not the head range, but broken through by the Chaktak-tsanpo. In the Lapchung-tso, situated to the north of this range, many rivulets coming from the main range collect and form the headwaters of the

Digitized by Google

river. On May 12th Sven Hedin crossed the Sangmo-bertik-la, surrounded by glaciers, and the Soma-tsanpo, which he describes as the biggest river in the interior of Tibet, emptying itself into the Teri-nam-tso. On May 19, after crossing the Teta-la, a most brilliant view unfolded itself of the whole Teri-nam-tso, Trans-Himalaya range, Targo-gangri, and Shakang-sham, the latter a particularly magnificent mountain. The lake has been almost correctly placed by Nain Singh, although only from native reports; but his Ngangon-tso nobody had heard of. Two days' march took them to the western end, and following the Soma-tsanpo past Mendong-gunpa, they crossed the Goa-la, and leaving the little Karong-tso to their left, struck one of the great salt roads leading from Raga to Tabié-tsaka. Chunit-tso was left to the right, and a junction should have been made with the main caravan on the Buptsang-tsanpo, in Bongba-kebyang; the caravan however had disappeared. On June 5th Sven Hedin said good-bye to his escort and followed the river down to where it joins the Tarok-tso. He was not allowed to visit the great salt depression of Tabié-tsaka, but turned west, past the Lunkar-gunpa, crossing the Nyapchu-tsanpo, flowing from the Men-la in the Trans-Himalaya range to the Poru-tso. West of this lake they crossed the ice and snow-covered Sur-la range to Rigi-changma, then down the Pedang-tsanpo, a big river, to Shobo-tso. From the Tayep-parva-la one can see nearly the whole of the Nganglaring-tso (wrongly called Chalaring-tso on the map), on which there are five islands, but no monasteries on them as marked on the map. The shape is also wrong, as its length is from east to west, not north to south. They skirted this big salt lake for two days, and reached Selipuk on June 26th. Here Sven Hedin was received with the greatest hospitality by the lamas, and, the main caravan rejoining him, he made his way south-west to Tokchen, crossing the Trans-Himalaya range for the tenth time by two passes, Ding-la and Surnye-la. Sven Hedin had at last had enough of Tibet, and he made his way down the Sutlej to Simla, keeping however while in Tibetan territory somewhat north of our route.

The geographical results of his journey may be summed up as follows :—

(1.) The discovery and careful exploration of the Trans-Himalaya range, and the filling in of the large white space on our maps north of the Brahmaputra from Gartok to Shigatse, and the discovery of the provinces of Bongba and Chokcu, which he has been the first to discover, that of Dokthol, on the map, not being in existence.

(2.) The discovery and exploration of the source of the main branch of the Indus.

These, I believe, are two absolutely new and most valuable discoveries.

(3.) Sven Hedin also visited and surveyed the true source of the Brahmaputra. This however had been approximately located, I think, by Nain Singh, and fairly well surveyed by Rawling and myself, though Sven Hedin having actually visited the real source, his map will be more accurate. I hope this Paper, written in a great hurry, may give the readers of the *Geographical Journal* some small idea of the value of Sven

Digitized by Google

Hedin's discoveries and the treat in store for them when he delivers his lecture. He has brought back with him innumerable observations and maps, which will enable him to draw a map of the whole of Tibet and Turkestan on the 1:1,000,000 scale. Some years must elapse before his scientific report and results can be published, but they should exceed in interest those of his 1899–1902 journeys. In the meantime he will publish as soon as possible a popular account of his travels.

Sven Hedin is not responsible for any opinions expressed in this Paper.

Digitized by Google

# RAILWAY SIGNALLING.

## ITS DEFECTS AND SUGGESTIONS FOR REMOVING THEM.

From a Lecture delivered before the Leeds local section of the Institution of Electrical Engineers by CAPT. A. GARDINER, R.E.

THE method by which control over the movement of trains is secured by the semaphore is too well known to need any detailed explanation.

We are all acquainted with the square-ended arm which in the horizontal position denotes that its post may not be passed by a train; and with the fish-tailed "distant" which merely warns the driver that he is approaching a "stop" signal, and indicates its condition at the time that he is passing the "distant," so as to ensure as far as practicable that if it be at danger he may be ready to stop before the square-ended signal is reached.

The system, despite all the scientific thought and attention that has been devoted to it, is still unsatisfactory. Its first and every-day difficulty arises at nightfall, when lights usually of the same colours do duty for both "stop" and "non-stop" signals, and a driver has therefore to interpret the meaning of the red or green lamp in front of him with the aid of its surroundings, and of his memory of the road, and of his position upon it.

Attempts, it is true, have been and are being made to remedy this obvious defect; but, for all the years that the semaphore has now been used for traffic control, no method has as yet been sufficiently successful to lead to its general adoption. The principal difficulties lie in the lack of certainty with which colours at all approaching each other can be identified under untavourable circumstances; and in the serious objection, that obviously arises, to any further complication of the maze of lights already formed by the signals of any important junction.

Apart from this defect however the system is in itself inefficient For although, with the aid of electricity, we can secure almost absolute immunity from error in the signal that it is desired to convey to a train, compliance with that signal, and hence the safety of the train, still remains entirely dependent upon a sequence of effects which that signal has to produce upon a human intermediary over whom we have little possible control. It has to be seen by the driver of the train, it has then to be correctly interpreted, and then to be promptly complied with.

In each item of this sequence there lies an element of chance which has but too frequently produced appalling disasters, and must continue to do so, so long as we have to rely wholly upon the human element for giving effect to the order which the signal is intended to convey. One instance of this element of chance is brought out by what is a

Digitized by Google

constant recurrence during every year, viz., fog, rendering the semaphores and their lamps either invisible, or visible only with the greatest difficulty. We endeavour to meet the danger that this state of the atmosphere gives rise to by detonators, which however may or may not explode. Injury in the fog to the signalman, or other failure to get the detonator on to the line, or to get it there in time, or to explode it when there, may still result in the semaphore being passed unseen.

Again, particularly on our busier roads, the concentration of attention imperative to ensure safety is incessant. A moment's wandering of the mind and a train may be again, as many have been before, doomed. Disasters unconnected with any atmospheric conditions have recently been prominently before us both in England and elsewhere in the Empire.

With the present external semaphore and lamp, each road and each branch from a road requires a separate signal; there are signals for stopping and signals for starting; signals as "advanced homes" and signals as "advanced starters"; each "home" with its attendant "distant," and but too many of the rest with repeaters or other auxiliaries, until the mass of semaphores and lights at a large station makes the interpretation of any one of them even on the brightest day, leave alone the finest night, a matter requiring a high degree of skill and memory. Yet out of this mass the driver is required to pick out promptly and accurately the one semaphore or lamp of each group that alone refers to his particular train.

The difficulties and dangers sketched briefly in the foregoing are so great that a recognition is undoubtedly growing of the need for some means of bringing the state of the signal emphatically and unmistakably to the notice of the drivers on their cabs, and making the neglect or unobservance of signals necessitate deliberate action on the part of the driver, so as to transform inertness into activity, and ensure that it is no dead man's hand or eye to which the safety of the traveller is entrusted.

Thus on the Metropolitan District Railway we see a description of actual train control, whereby a train running past a signal at "danger" has its brake applied automatically through the impact of an arm on the track against a lever carried on the train.

The adjunct points the direction in which railways are undoubtedly moving, but that is all. For with the train stop placed where it is, viz., at or near the "home," it applies too late—at all events for anything but slow traffic and light trains. Once a "stop" signal has been passed, a train may be in desperate danger, for the obstruction may be close beyond; and a train at high speed, tripped by the train stop while passing the "home," must travel considerable distance before it can be brought to a stand, much further than any permissible "overlap," such as may be suitable for the traffic of the District Railway. On the other hand, were the train stop placed sufficiently far in advance of the signal to ensure that the train will have been stopped before the signal is reached, its operation becomes necessarily one of every-day occurrence, and the blow of the arm against the lever then rapidly destroys one of

Digitized by Google

them or both. Even were a situation as on the District Railway otherwise possible, an impact device would not be practicable for trains travelling at 45 to 70 miles an hour.

On the Great Western Railway train control is not attempted, but they also disclose the craving for something more efficient than the semaphore in the cab signal, which they have substituted for the ordinary "distant" on some sections of that line. And there again, while the invention, excellent as far as it goes, appears to be too limited at present in its scope for it to be the last word in cab signalling, we see another tendency of the new movement.

For immediately a really reliable substitute for one of our existing semaphores is discovered that semaphore *disappears*. The Great Western cab signal is not a signal repeater—it is a signal; and the semaphore being no longer required for the particular indication that their cab signal provides, it has begun to be abandoned as far as that indication is concerned, as it will undoubtedly be abandoned for every other indication once a really efficient substitute is found. No half-and-half system will stand the test of time. If a cab signal is reliable, the driver will pin his faith upon that, and the semaphore becomes superfluous. If it is unreliable, the driver will adhere to his present signal, and the equipment in his cab will fall into disrepute and disuse. The regard in which mere repeaters are held receives illustration in almost any cabin containing them on any railway in the world.

A mixed system of signalling, such as one with the "distant" in the cab and the "home" on the track, contains, moreover, a new element of danger, for the "distant" is not a final signal. Even though the "home" be off when the "distant" is passed, the signalman has the option of throwing it to "danger" before its post is reached by the train, and may thus possibly avert an accident. But such occurrence is comparatively rare, and there is therefore risk of the driver learning to treat the "safety" indication in his cab as full permission to proceed, and relaxing his look-out for the signals on the track, thus overlooking a possible confliction between the actual state of the "home" signal and the indication of its state as previously given to him on his cab.

This danger appears to have been recognized by the North-Eastern Railway, and in their signal they seek for something more than the single indication, and instal a series of signalling points, each of which confirms, or may cancel, the indication previously given.

The North-Eastern Railway system goes much further in many ways in the desired direction of a complete system of signalling on the cab than does that of the Great Western Railway; but unfortunately its signal has a "gravity" safety position, being operated by a magnet that is "dead" for the safety position, and requires to be excited in order to show danger. The result is that any failure in the signal magnet circuit can but mean a failure to remove the safety indication; and although the equipment provides auxiliary detection for certain causes of such failure, still the defect is sufficiently grave to, it would seem, limit the scope of this system strictly to repeating the external signals. For the reasons already given this is an undesirable handicap,

Digitized by Google

making the system fall far short of the ideal that railways are seeking for.

Another respect in which our present system of external signals woefully breaks down is as regards reductions of speed; for a railway cannot always be built so that from end to end it is fit for speeds that are perfectly safe over the greater part of it. Even if so built, portions will occasionally require replacement or repair, and during the execution of these works will not be fit for the maximum speed, and the unusual presence of a man upon the line with a green flag or lamp is commonly taken (although the green flag is in itself merely the opposite to the red) to indicate the necessity for proceeding with unusual caution. The efficiency of the system is again of the lowest, for safety once more depends wholly upon human obedience; and obedience, moreover, in this case of a high moral order, for it is almost invariably impossible to ascertain at what speed any particular part of line has been passed over, and the driver risks a larger measure of blame for any delay that may result than he ensures praise for strict compliance.

With signals on the cab, not only is it possible to give a "reduce speed" indication that cannot be confounded with any of the other indications, but it becomes possible also to make that signal act directly on the motive power of the engine, and so enforce compliance; and further, by providing for the automatic removal as well as the automatic exhibition of the signal, it becomes possible to obtain a record from which the actual speed over the restricted section can be indisputably established.

Reference has been made to the systems in force or being tried upon the District, the Great Western, and the North-Eastern Railways, chiefly as evidence of the fact that weak points are recognized in the present system of railway signalling, and that the idea of a system of cab-signal control of trains is not merely a visionary theoretical scheme, but one which in some form or other has for some time been engaging the attention of practical men. I propose now in the first place to outline what appear to be the main essentials of a perfect system of train control with its resultant effects, and then to explain how it is suggested practically to secure their fulfilment.

A perfect system of train control by cab signals should, to meet all the requirements of traffic working, fulfil at least the following conditions:—

1. It must comply with the essential principle that any breakdown of the apparatus that can impair its accuracy shall completely remove the "safety" indication and produce either a "danger" or a "disabled" signal.
2. It should be wholly in the cab, and not depend partly upon signals in the cab and partly upon signals on the track.
3. It should signal, not at one point or several points, but at every point, so that a train shall be continuously in receipt of a positive signal.
4. It should simultaneously act directly upon the motive and brake power of the train, so that it shall be automatically obeyed, and not having been at great expense automatically given, depend wholly upon human compliance.

Digitized by Google

5. It should provide an audible as well as visual "danger" signal, as an additional safeguard against momentary inattention on the part of the driver.
6. It should enable an automatic record to be maintained of all signals received and of the exact time of receipt.
7. It should provide that, automatic control having been set up, it shall be practicable for the driver to reassume his control over the motive and brake power of his train without interfering with the efficiency of the apparatus in delivering further signals.

This last requires, perhaps, special consideration. Writing recently in the *Times Engineering Supplement*, Professor Ayrton advocated the shutting of power off a section of electrified line whenever the signals are against a train. Professor Kapp, in his still more recent lecture on the "Electrification of Railways," delivered at the Royal Institution, explained how this is actually done on the Valtellina Railway.

With a system of cab signals and control complying with the requirements set forth above it would be easy on a steam line, as it is already attractively simple on an electric one, to cut the power irrevocably off the train, when that train is desired to stop, and to restore the power automatically only when it is desired to permit the train to resume its course.

With a manually controlled system of signalling, such a step is not altogether impracticable. The driver's duties on a steam train would then be of a very limited order, while on an electric one his presence at all conceivably becomes *theoretically* unnecessary.

A purely manual system of signalling is however, as compared with the automatic, both deficient in safety and incapable of dealing expeditiously with a dense traffic. With automatic signalling, as far as indicating the condition of the track is concerned, manual control is not only superfluous, but even undesirable. It is essential however that if any derangement or irregular occurrence shall affect any automatic signalling appliance at all, its interference shall take the form of the danger indication, and while the better of the approved systems have reached such a degree of perfection that derangements are rare, and of the order of 100,000 movements per failure, still it is out of the question from the point of view of general railway working that it should be possible for such a derangement, however occasional, to hold up indefinitely (as it would were the complete cycle of the system irrevocably automatic) the whole of the traffic over a considerable length of line. Moreover, apart from derangements of equipment, it is sometimes necessary in railway working to break through normal rules, such as, for instance, when two trains are brought to one platform, or into close proximity with some block or breach, the existence of which must however essentially cause an automatic equipment to give the danger indication.

The presence of the human element somewhere in any automatic system of train control for the purpose of stepping in and bringing human intelligence to bear when the machine has temporarily reached its limit, may therefore be considered an accepted postulate. This being so,

Digitized by Google

of the two component parts of such a system, the fixed or track part and the moving or train part, on either of which this human element may be located, the most advantageous, both theoretically and practically, is unquestionably upon the moving part.

A system of automatic control over the movement of trains must therefore, to be practical for general adoption, comply with the condition that while it ensures automatic obedience of the train to the signal received, it admits of being overruled without serious inconvenience when circumstances require, but overruled only as the wilful and deliberate act of the driver in supreme charge of the train and not as a matter of oversight.

The method proposed involves, as will have been already understood, the eventual entire abolition of the semaphore and its lamp, with the following immediate results :—

1. In place of the usual external signals we obtain primarily indications in the cab itself, visible, and if desired audible, at all times despite fog or storm.
2. For the operation of a human driver, liable to err in picking out which particular lights or arms of each signal group alone refer to his particular train, it becomes possible to substitute automatic selection and to present the result alone in unmistakable form before the driver in his cab.
3. For verbal evidence, frequently defective, often false, as to signals received during a run, we are enabled to secure an indisputable automatic record of the signals received, it may even be of the action taken in the case of the "danger" indications.
4. For a signal that may mean "stop" and may mean "prepare to stop," and which frequently can but with difficulty be correctly interpreted, it substitutes a "stop" signal that always means "stop," as well as a "danger" signal that always means "danger."
5. For a requirement of traffic working that has not as yet been adequately met it provides a "reduce speed" signal, disregard of which can be subsequently detected or proved.
6. Finally, we secure indications which can readily be made to act directly on the engine itself, and be automatically obeyed, in place of indications compliance with which must depend wholly upon the unchecked human element.

The means are as follows :—

Parallel to the running rails is laid a metallic "track conductor" (T.C., *Fig.* 1), probably of tee or angle iron, of section about $1\frac{1}{2}'' \times 1\frac{1}{2}'' \times \frac{1}{4}''$, and carried on wooden posts 6′ to 10′ apart at the maximum distance from the track that the running dimensions admit of. Better insulation may possibly be found necessary, or the conductor may be preferred between the rails—but these are details that experience will settle. The height of the track conductor above rail level must suffice to ensure that the moving contacts shall clear the top of the rails at crossings, metalling of cart roads, and so on; and in order to enable engines to run either

Digitized by Google

chimney or tender foremost with a single track conductor they must, if the conductor is placed externally, carry the contact devices in duplicate; so that the conductor is free to be placed for short lengths on whichever side of the line happens to be locally most convenient.

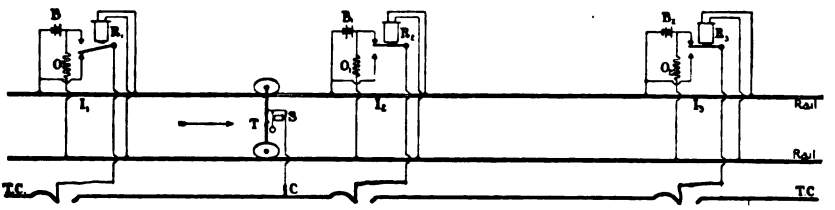



FIG. 1.

The track is split up into track circuit sections of the desired length (insulated joints $I_1I_2$), and the rails within the limits of these sections are bonded together on each side by one of the usual track circuit wire bonds. At one end of each section is a track relay ($R_1R_2$), and at the other a track battery ($BB_1$) or other source of power for the track relay. The relay and the source of power are each connected to the rails in such a way that when no train is on the section, the relay is excited and its armature drawn up; when a train enters the section the relay is short-circuited by its wheels and axles, and the armature falls away.

On an electric line Brown's patent arrangement of two polarized relays, as used on the District Railway, could readily be utilized to prevent any risk of operation of the signals by leakage currents.

The armature of the relay carries certain contacts, which are closed when the armature is attracted, and for the purpose of this signal it carries also other contacts, which will be closed when the armature falls away.

A resistance ($O_1O_2$) is inserted between the track battery and the track to prevent the battery itself being short-circuited by the trains; and a parallel circuit is then taken from the battery positive, through the contacts of the near track relay, to the track conductor, as shown in the figure. The track conductor in each section is thus, when the relay controlled by the section ahead is energized, charged with the potential of the track battery above the negative track rail, but is dead when that relay is shunted. Consequently when any track circuit section is occupied, the track conductor of the track circuit section in rear is dead.

As far as the first and principal indication to be given on the engine is concerned therefore, viz., "clear" and "stop," all that is required is some means of collecting current from the track conductor, and an electromagnet which will, when energized, show a "clear" signal, and show a "stop" signal by the action of gravity when de-energized.

The action will then be as follows:—

If the section ($B_2R_2$) ahead of a train is clear, its relay $R_2$ will be energized. The battery $B_1$ will have part of its current shunted through the fixed resistance ($O_1$) and the wheels and axles of the train (T), while part of the current will pass *viâ* the track conductor and the collecting

Digitized by Google

devices on the engine, and *viâ* the coils of the signal magnet (5), to the negative rail. The train will thus receive the "clear" signal. Should, on the other hand, the section ahead be occupied (as is the section $B_1R_1$), the relay ($R_1$) being de-energized, the track conductor will be dead, and a following train will receive the "stop" signal.

The lower contact of the relay is arranged to connect the track conductor directly to the negative rail of the section, so that in the de-energized position of the relay it will be impossible for there to be sufficient difference of potential between them to retain the signal armature in the "clear" position. Any type of collecting device found suitable can be used—brush, shoe, spring, or, if need be, even trolley and wire—and any number of such devices can, if necessary, be placed in parallel; to ensure one of them picking up the trifling amount of current that will suffice to work the signal, the collecting devices can also be preceded by a brush or scraper to clear the way, or a steam jet can be arranged so as to play upon the track conductor immediately in front of the engine contacts.

To control the motion of the train, the armature of the signal magnet is supplied with contacts placed in a local circuit on the engine, which includes electromagnetic valves on the main steam pipe and the train brake pipe; the former to shut off steam, the latter to admit air to a vacuum equipment, or release the air from a Westinghouse one whenever the circuit is opened by the fall of the signal armature.

The local circuit on the engine would also, if desired, include a whistle bell or buzzer, designed to operate when the signal falls, so as still further to attract the attention of the driver.

The cessation of the actively produced, contrary to gravity, "clear" signal would thus not only cause the "stop" signal to appear, but it would also give rise to an audible signal, and further shut off steam and apply the brake. Working with such a system, it would be the duty of the driver, on the receipt of a "stop" signal, then and there to take steps to aid the automatic control in bringing his train to a stand with all reasonable speed. This done, he will await the receipt of the "clear" signal, knowing that it will reach him, whatever his position on the track, the very instant the section ahead is clear.

The shutting off of the steam can cause no mechanical inconvenience, and the application of the brake can be made just as gradual as may be desired, while the apparatus can be designed with means to restore the steam and close the brake pipe whenever the driver elects to do so, and until such time as the engine shall have received another "clear" indication and then another "stop."

The models have been made to work without any driver, and consequently restore the motive power on receipt of the "clear" signal. This is not suggested for actual practice. The driver would be expected to close his regulator on receipt of the "stop" signal, and would be required to restore the vacuum or air pressure by his own action on receipt of the "clear."

The recorder consists of a chart revolved by clockwork under a pen, which is controlled by an electromagnet placed in a circuit of the local

Digitized by Google

battery on the engine, and arranged so as to mark the chart when the signal magnet is in the released or "stop" position.

Were it possible invariably to act up to normal rules, so that it would never be necessary for a train to proceed against a "stop" signal, nothing further in respect of the "clear" and "stop" indications would be required than has been outlined above. Such however is not the case, and it is necessary to provide that a train receiving a "stop" signal for which no obvious cause exists may be able, after waiting a reasonable period, to proceed cautiously to the end of the block reported by the automatic signals to be occupied.

A reference to *Fig.* 1 will show that a train proceeding in this manner might under suitable circumstances eventually receive a "clear" signal, although the block were occupied. It is necessary to avoid this, a necessity which fortunately there is little difficulty in providing for. The key to the situation is that part of the track conductor last passed over in the "dead" section which must always precede an "occupied" one.

A train following the train "T," and approaching from the left of the plate, will be perfectly safe up to the insulated joint $I_1$; should it pass $I_1$, its collector and its signal magnet will be in parallel with the collector "C" and signal magnet "S" of train "T."

To prevent this it is proposed to make use of a ramp to open the signal circuit of the following train on the same general principle as that adopted by the Great Western Railway. The track conductor is ramped in the neighbourhood of, and to the facing side of, each insulated joint. The cab signal has an additional "danger" magnet which controls three contacts, one for its own local circuit, one in series with the collector and the signal magnet, and one to operate an audible signal. Further, when de-energized it causes a shutter marked "danger" to drop by gravity in front of the signal window. The danger magnet is normally excited by the local battery on the engine, the circuit being through its coils and its own contacts in series.

One collector on each side of the engine is so arranged as to be normally insulated from this circuit, but, when the collector is raised by means of a ramp, it breaks the local circuit and substitutes for it another circuit from the ramp through the collector and the coils of the danger magnet to earth. If however the substituted circuit is dead, the armature of the danger magnet falls away on the opening of the local circuit, and in doing so breaks that circuit a second time at its own contacts. The local battery is consequently unable to resume control of the magnet after the engine has quitted the ramp. But the circuit of the signal magnet is also taken through the contacts of the danger magnet; and consequently the fact of the track conductor being alive beyond I does not result in a "clear" signal. The train would thus traverse the section $I_1I_2$ (which is either occupied in some way or else unsignalled in consequence of a breakdown of its equipment, and which is therefore in either case an extremely dangerous zone) with the "danger" signal before the driver. This would be registered on the recorder, and the length of the section being known, the speed at which he traversed it would be indisputably established. If the delay had been due to the relay ($R_1$) being out of order, the track conductor in the section $I_1I_3$ will have been alive.

Digitized by Google

Before leaving that section the engine must traverse its danger ramp, which is, however, this time a live one. The auxiliary circuit to earth which is made temporarily by one of the collecting shoes while on a ramp will now energize the danger magnet and close its contacts, enabling the local battery to resume control as the engine leaves the ramp and closing the circuit of the signal magnet. This is the normal action when quitting each "clear" section, the driver then requiring no notice whatever.

The above indications deal with the track between stations. We may now consider the approach to a station. The train may run in or through on the straight, or it may have to be turned off on to a siding or branch. In the latter case the driver should approach with reduced speed, since it is not safe for him to take points for a turn-out at the same speed as for the straight. To give the warning to reduce speed we utilize an independent ramp, placed (if the track conductor is outside) between the rails of the track.

An additional magnet is supplied to the engine equipment and an additional contact device for the "reduce speed" ramp. The magnet works on the same principle as the "danger" magnet, but it is proposed that it should merely shut off steam and not affect the brake; this is however entirely a matter of what may be desired. The "reduce speed" magnet has a suitably worded shutter, which appears by the action of gravity at a separate window placed as close as possible under that at which the "stop," "clear," and "danger" signals are shown. When the magnet is excited the "reduce speed" shutter is drawn up, and the window is blank.

The ramp circuit is dependent upon the points, and when these are set for the straight and all is clear, the "reduce speed" shutter will not drop; when set for a turn-out the driver will receive his warning, and with the aid of the recorder it will be possible to determine what action he took upon it. In India, at all events, the speed at which points and station yards are traversed is somewhat frequently a subject of interdepartmental discussion.

But points may be set for the straight when, as a matter of practice, all is not clear; for a train may be already there, and it may be desired to bring another up against it. The state of the "reduce speed" ramp will therefore depend further upon the relay of the station track circuit section, and its mechanical action will only be electrically cancelled when all is clear for the train.

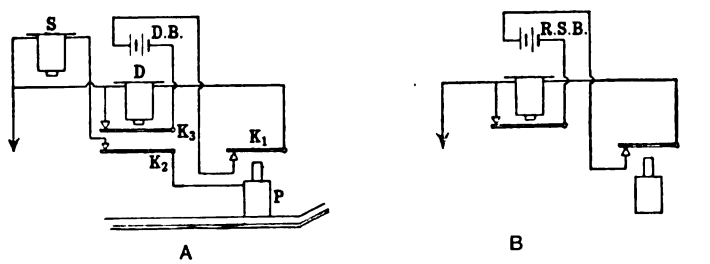



FIG. 2.—*Diagram of (A) Ordinary Cab Circuit, (B) "Reduced Speed" Circuit.*

S "Stop" Magnet.
D.B. "Danger" Battery.
P Plunger.
$K_1$ $K_2$ $K_3$ Signalling Keys.

Digitized by Google

The "reduce speed" signal will, like the "danger" signal, be entirely beyond the control of the driver, and to remove it a live ramp will be placed at the point beyond which restricted speed is unnecessary.

In the "reduce speed" signal we have all that is necessary to deal with any temporarily or permanently dangerous section of line, viz., a pair of temporary or permanent ramps, the one dead to apply the signal, the other charged to remove it, coupled with a recorder to record the duration of the "reduce speed" signal. The distance between the ramps being known, this gives a permanent record, to be filed in the Locomotive Superintendent's Office or submitted to the Manager, of the regard that has been paid to the restriction.

The above has described a "clear" and a "stop" signal for normal use, and has outlined a method of train control—a "danger" signal that comes into play only when the "stop" signal has for any reason been disregarded, and a "reduce speed" signal to meet the case of ordinary speed restrictions, and of the necessity for cautious driving when leaving the straight for a turn-out.

The model shows how these signals can be subjected to manual semi-control in the neighbourhood of stations, so as to meet, it is believed, every reasonable requirement of traffic working.

It is however possibly further necessary to advise the driver of the actual route set for his train. With certain not inconsiderable limits this can readily be done by means of bars on the track which will be normally dead, but one or other of which will be charged with current according to the setting of the points. The engine will carry a set of contact springs or other device and an indicator which will show the number of the ramp which is charged with current. The indication will not be a primary signal, and the absence of any indication can be treated as a "dead end" signal. The model shows three tracks, each of which is "indicated" in this manner. It is believed that the actual number of the route he is to take is not really required by a driver, and that three indications meet every reasonable need. "No. 1" would then mean "Straight road—all clear"; the "*reduce speed*" *signal* and "No. 2" would mean "Points set for a clear loop line"; and the "reduce speed" and "No. 3" would mean "Points set for a dead end or an *occupied* line." Each indication would be recorded, and under instructions "no indication" would be treated as equivalent to "No. 3."

As regards the safety of such a system of signals as here advocated, the essential signal of the equipment is that which gives the indication "clear" and "stop." The "stop" signal is entirely a normal mechanical signal, and has to be held off continuously by a current received from the track conductor under the control of the track relay. Consequently, even if the conductor be carried away altogether, the only result can be to stop the train. In the released position of the track relay, the track conductor will be short-circuited, as explained, on the negative lead, so that even leakage currents cannot operate the signal. A leakage across an insulated joint merely lengthens the track circuit section. The control of the motive power and the brake can also be designed

Digitized by Google

so as to be actively prevented from acting by the presence of an electric current, the cessation of which from any cause will cause them to stop the train, and these parts of the equipment appear therefore to comply with an unexceptionally high standard of safety.

The "reduce speed" and (subsidiary) "danger" signals, according to the method proposed, are gravity signals actively held "off" by the presence of a current, and coming into operation when that current fails. Short of the actual removal of the ramp itself (the equivalent to which in semaphore signalling is the removal of the post itself), every derangement can only result in the signal giving the precautionary indication. The "danger" signal could further only be given after a "stop" signal, and after it had been decided by the train staff to proceed against the "stop" signal, so that it would only come at a time when the train would be moving very slowly and much on the alert, so that even the removal of the ramp (involving a gap in the track conductor) should in this case be detected.

As regards audible signals in the case of continuously ringing bells, buzzers, trumpets, etc., a current must be present to create the noise; where possible therefore a steam or air whistle will be a better agent for this purpose, the contrivance then being arranged that the presence of the electrical current prevents its sounding.

As regards the indications of the route, it is proposed to give these by the transmission of a current. They are not however in any respect part of the signalling system essential to safety of movement; the "reduce speed" signal would operate whenever special caution is required, and any failure to receive a route indication, as stated, be treated as indicating the most dangerous route.

For single-line working there need be no alteration whatever to the engine equipments, and it will therefore be a matter of indifference to the driver whether he is passing over double or single line. The track equipment will still consist of a single track battery and a single track relay per track circuit section; but there will also be a polarized relay, the duty of which it will be to switch the battery and relay connections over from "up" line working to "down" line working, and *vice versâ*.

The polarized relays would be in the circuit of the "line clear" instrument used for the despatch of trains, and would be arranged to work entirely automatically in connection with the issue of an "up" or a "down" token. One result of the equipment will then be that should a train, by overrunning or any other mischance, proceed in a contrary direction to that for which the track has been "set," the rear end of the train will cause the engine to get a "danger" signal, and will thus automatically bring the train to a stand. Even with the best of "line clear" token systems, since cases are not unknown of drivers accepting "line clears" that were not intended for their particular trains, collisions must remain a constant risk in single-line working. A grave accident occurred only a few months ago in India when two passenger trains collided head to head, over 100 Europeans and natives being killed.

An objection occasionally urged against giving signals on the cab is

Digitized by Google

that they are seen only by the engine crew. The presence of a self-recording instrument however gets over this difficulty as far as corroborative evidence is concerned, and the automatic application of the indication to the engine itself largely meets the objection as far as the immediate safety or working is concerned, while in most cases there would be little difficulty in repeating the signal if desired in the brake van or on any other car of the train.

Although it is practically certain that if cab signalling is adopted the semaphore will eventually be superseded altogether, it would be many years, no doubt, before the conversion of the equipment of any road and its locomotives would be entirely completed, and it is therefore essential that the cab signal shall be capable of working in conjunction with the existing semaphores. There is no difficulty on this score in regard to the proposals now made, and the cab signal can be arranged that it cannot show "clear" when the semaphore is "on," although it will show "stop" should the semaphore be improperly "off." The model provides an illustration of this feature. The period referred to during which there would be dual signalling would moreover serve a useful purpose in training the staff to the new departure, and giving them confidence in its reliability.

The two most obvious objections that can be advanced to a continuous signal on the cab are (1) the necessity for contact; (2), the cost.

With reference to the contact objection, it will undoubtedly be a very great advantage to every one—except, perhaps, those who own copper—when we can do our electrical transmission of power by "wireless"; but those days are not yet, and meanwhile the late lamentable disasters have forcibly brought home to all of us the ever-present risk of calamity to those for whose safety railwaymen are responsible, which is inherent in the present system of train control, and which cannot or should not be disregarded because the future has further improvements on what our present knowledge admits of. Therefore, while every attention is being paid to the possibilities of avoiding the necessity for actual contact in transmitting the indication to the locomotive, pending success in this direction, too much of a bogey can easily be made of such difficulties as present themselves in preserving this contact. The current to be transmitted need not, as has already been pointed out, be a large one, the contact devices (with the exception of the single one on each side required to break the local circuit of the danger magnet) need not be other than of the simplest description, and can be multiplied *ad libitum*, the voltage of the track conductor can be put up to anything found absolutely necessary, the pressure of contact need not be great, the surface of the conductor can be made to approach a knife-edge, and there are many means of clearing it of ordinary frost and snow. The height suggested for the conductor is 3″ above rail level, or some 9″ above the sleepers, which would keep it well above the actual snow level of any ordinary snowstorms, while even heavy snow can only at worst produce a danger signal, and not, as it may with the semaphore (by weighing it down or freezing it), a false "clear."

With reference to the remarks above on the subject of the contact

Digitized by Google

objection, the change to some other method of transmitting the desired indications would not in itself modify the system of cab signals advocated, but would be merely an alteration in certain details easily introduced in the event of success being met with, and it does not seem desirable to postpone taking advantage of the great gains in safety which the system offers, awaiting an improvement that is not essential.

As regards cost, comparison can, of course, only be made of an automatic cab signal with other modern automatic outside semaphore systems which all involve electric track circuits. Auto-signals in this country are mostly of the electro-pneumatic type. Up to the relay, they and an automatic cab signal have everything in common—a bonded running rail, a source of power for the track circuit, and a system of track relays. They then require a pipe to convey air, pumps to pump air into this pipe, traps to carry off the water. Under the most favourable circumstances the leakage and losses from condensation and friction in these pipes represent a considerable percentage of the air which has to be pumped in at appreciable expense. A cab signal requires a metallic conductor that need hardly carry more metal than the pipe, if as much, will be no more difficult to lay, and needs no traps. In place of pumps the existing track batteries will merely have cells added to supply the desired voltage. The degree of leakage would be practically simply a matter of the expenditure permitted on insulation, and could, if wished, be *nil*, since no useful current flows except when a train is on the section. So much for the track. As regards the signal for the outside automatic semaphores, usually at about every mile of the track, it is proposed to substitute a signal apparatus on each engine. The number of locomotives per mile on an English railway are not known to the author, but in India the standard gauge system with the largest number of engines is the Eastern Bengal State Railway, with 0·4 of an engine per mile, a figure which had not been surpassed by any other of the Indian gauges up to April, 1907.

A primary signalling equipment consisting of "clear," "stop," "danger," and "reduce speed" indicators, with the necessary contacts, etc., could probably be fitted, at a rough estimate, for about £20 per engine, which at 0·4 of an engine per mile works out to £8 a mile. This can hardly be in excess of what the automatic semaphore with post, valves, or relays, and raising and lowering mechanism, at one semaphore per mile works out to.

Fully equipped with train control as proposed in this Paper, the cost would, of course, exceed this figure, but it is believed that the track work between stations with half-mile sections (instead of 1 mile, as with the semaphore) need not exceed from about £140 to £160 per mile, and the engine equipments to from £40 to £50.

Yards would continue to be power or manually worked on any of the well-known systems, but without semaphores or lamps, and the saving in these would go far to meet the cost of the conductor, reduce speed ramp and indication bars, and their electrical interlocking with the points. The cost of the track work at stations would thus be little, if at all, in excess of present requirements. In this Paper, in discussing cab

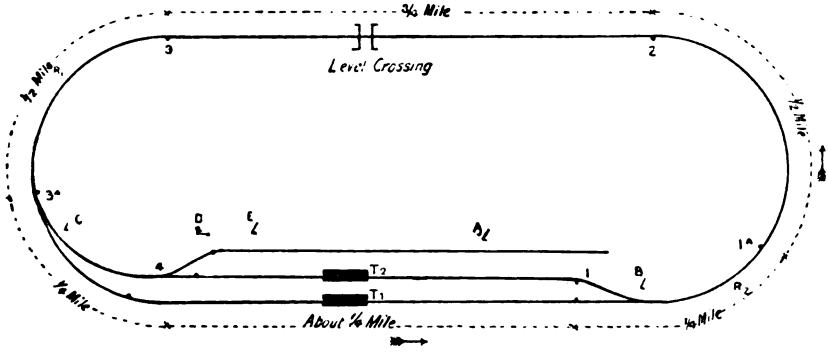
Digitized by Google

signals *versus* outdoor semaphores, comparison has, as stated, been made with an up-to-date track-circuited installation, such as *are now being installed* on the leading English railways. In India, where the track circuit is as yet practically non-existent, the cab signal, with its automatic indication of the condition of the section of line ahead, and automatic "stop" in the event of this being obstructed, would be of immense advantage, not only on account of the trying effects of the climate on the alertness and physical condition of the train staff, but also of the protection it would afford against the wash-aways, failures of bridges, and other damages to the roadway, which are, unfortunately, practically unavoidable in the tropical downpours and cyclonic storms with which all parts of that country are at times visited, and which have led to disasters owing to failure of the human agency to detect the damage and warn the approaching train.

---

The following is the description of a model exhibiting the system of train working with engine cab signals, as patented by Capt. Gardiner, and which is to be seen by appointment with Colonel Gardiner, 28, Barkston Gardens, Earls Court, S.W., or at The Accumulator Industries, Ltd., 4, White Street, Moorfields, E.C.—[Ed., *R.E.J.*]:—

The model represents a length of railway laid out in an oval form, starting from a station provided with a passing siding and one dead end siding, and running round the oval to the same station again.




| | | | |
|---|---|---|---|
| I IA 2 ETC. | Limits of Signal Sections. | D | Stationmaster's Calling-on Key. |
| A | Stationmaster's Starting Lever. | E | Stationmaster's Admission Lever. |
| B | Trailing Points Lever. | RI R2 | Reduce Speed Ramps. |
| C | Facing Points Lever. | | |

The model track is wired to represent the left hand (*i.e.*, inner) track of a double line, the trains running normally as indicated by the arrows in the opposite direction to the hands of a clock.

For single line working no modification of the engine equipment would be needed, but to introduce the additional track arrangements on a model of a practicable size for room exhibition, and in which the length of the sections is necessarily out of all proportion to the size of the

Digitized by Google

locomotives, would undesirably complicate it. To exhibit the system of working proposed, the model track has been divided into six sections. Of these in actual practice none would be less than say ¼ mile in length, whereas in the model some have necessarily been reduced to two or three engine lengths only. Normally, the length of a section will usually be made the minimum in which a train running under the least favourable circumstances for control can be stopped with certainty. The figure would be decided by the locomotive officers of each line concerned, but would probably be about ¾ mile in length. At the ends of a station however short auxiliary sections will usually be introduced for the purpose of facilitating working within the yard. These are shown at 1A and 3A in the above drawing and their purposes can best be explained on the model itself.

While the system was not originally designed as one for controlling the despatch of trains from crossing stations on a single line, incidentally it affords much security against what is a fertile source of accident, viz., the departure of, let us say, a down train into a section that is already occupied by an up train. An investigation into the records of one Indian railway showed that in the space of two years there had been six detected cases in which an "up" driver had taken the line clear intended for a "down" train standing in the same station, and *vice versâ*. Though in these cases, fortunately, there were no disastrous results, India has within the past few months had two most serious collisions owing to "up" and "down" trains meeting on a single line. With the arrangements proposed, as can readily be shown in the model, it is practically impossible for a train other than the one intended by the stationmaster to start to leave the station.

To exemplify the system of working proposed, the following movements of trains will be exhibited in addition to any others that may be desired. Assuming two trains T1 and T2 (see drawing) to be standing at the station :—

(I.). The departure points B having been correctly set, the stationmaster with the lever A gives the starting signal and the train moves off. The points and the starting lever being electrically interlocked, permission to start cannot be given until the points are correctly set.

(II.). The train runs round the oval, but as it approaches the level crossing, something having gone wrong there and the gates not being properly closed against the cart road, a "stop" signal is automatically shown on the engine and its motive power is automatically cut off. On the gates being correctly closed a "clear" signal is automatically given and the train proceeds.

(III.). On reaching the point 3 (which is where the station distant signal would be situated in semaphore working), assuming the points C set in error for the loop line which is occupied by the train T2, whether the stationmaster has pulled over his admission lever or not, the approaching train receives automatically a stop signal. When the train T2 is allowed to start and has cleared the loop, the train T1 can be admitted by means of the stationmaster's admission lever.

(IV.). The stationmaster having finished with the train T1, the points

Digitized by Google

are set and he pulls his starting lever, but until the leading train has passed the point 2, T1 continues to receive a "stop" signal. When T2 clears the section 1-2, T1 receives a "clear" signal and is able to proceed.

(V.). Assuming T2 to be stopped near the level crossing by something wrong, T1, which is following, automatically receives the stop signal on entering the preceding section; after waiting the prescribed period, T1 proceeds cautiously (against the signal) to find out what is the matter. Before he can enter the occupied section his "stop" signal is automatically superseded by a "danger" signal, preventing him from receiving a "clear" signal, although T2 may be receiving a "clear" signal, and is in the same section as that into which he has now entered. After waiting a sufficient time, T1 would again proceed cautiously. Assuming T2 to have meanwhile proceeded, if the section ahead of that occupied by T1 is clear by the time that T1 is about to leave it, he then (*i.e.*, on passing the point 3) receives a "clear" signal once more, and is able to proceed.

(VI.). The trains will now be started out afresh from the station, T2 leading. On returning to the station again T2 is stopped. The points remaining set for the siding on which it is standing, the following train T1 receives a "stop" signal at the point 3 and stops. The stationmaster wishes it to draw up to some nearer point; having allowed the train to come to a stand, he depresses a "draw on" key, preferably in some pre-arranged manner, which the driver would comprehend to mean "draw on, but be prepared to stop"; the stationmaster can then stop the train at any desired point between 3 and 3A by releasing his "draw on" key D. Beyond 3A the control is entirely automatic, and movement against signal would have to be done by flag or verbal message.

The next two experiments are intended to show the conjoint working of semaphore and cab signals, where the former may happen to exist or be considered desirable.

(VII.). Semaphore signals will now be erected and a train started. The semaphore signals being at danger, although everything is clear for the approaching train, the signal on the cab shows "stop" as soon as the distant signal has been passed; on lowering the signals the cab signal shows "clear," and the train enters the station.

(VIII.). A train is again started. The points are set for the occupied siding, the semaphores are incorrectly lowered by mistake, the cab signal shows "stop" until the points are set for a clear line.

It having been thus shown how the cab signal can be interlocked with a semaphore system so as to prevent the cab signal showing "clear" while the semaphore signals are at "stop," without at the same time destroying the protection afforded by an automatic as compared with a manual system, the semaphores will be removed again and one of the locos. will be connected by flexible wire to the full-size equipment erected at one side of the room. This equipment comprises:—

(1). A full-size cab signal.
(2). An equipment of audible signals, viz., horn for "stop," buzzer for "danger," and bell for "reduce speed."

Digitized by Google

(3). An equipment comprising in principle the magnetic control over the steam pipe and brake pipe of a steam train. In order to show what its action would be, the electro-magnets cause two of the following four signs to be lighted up:—1, steam free; 2, steam off; 3, brake free; 4, brake on.

In practice it is not proposed to actually start a train automatically, but merely to restore to the driver the power of doing so, hence the expressions "Steam free," "Brake free." The exact method of control considered desirable will vary very largely with the views of the individual authorities of any particular line, and can be as complete or as non-existent as that particular line desires. In the opinion of the inventor the following is a suitable arrangement, and the model has consequently been designed accordingly:—

On the receipt of the "stop" signal steam will be entirely shut off (red lamp lights showing "steam off"), and the brake will be gently applied (red lamp lights showing "brake on"). The driver will now personally close his regulator and take charge of his brake so as to stop the train as speedily as reasonably convenient. This done, he will free his brake and steam pipes by pressing two buttons in the apparatus, and thus be placed again in full control of his steam and brake power. (On pressing these buttons in the model the red lamps go out and white ones light up, showing "brake free," "steam free"). Meanwhile, since receipt of the "stop" signal, the horn will have been sounding. By pressing a button the horn can be stopped, but will be automatically put ready to sound again on receipt of the next "stop" signal by the action of receiving the next "clear" signal.

On receipt of the "reduce speed" signal (hereafter explained) steam will be entirely shut off (red lamp "steam off" lights up). The driver will now personally close his regulator and, if necessary, personally apply his brake. This done, he can free his steam pipe by pressing the steam button (red lamp goes out and "steam free" lights up); he can then restore as much steam as he may require. Meanwhile the bell has been ringing, but can be stopped by pressing the bell button.

The above method of working the apparatus has been put forward as a proposal only. The principle of automatic control compelling observance of signals having been established, the detail of how it is to be applied would doubtless be varied on different lines and under different circumstances. Some consider the motive and brake power of the train should only be automatically controlled in the event of the driver failing to take proper action. It is hardly necessary to explain that to meet the requirements of those holding this view there would be no difficulty in causing the automatic control to come into action only upon receipt of the "danger" signal, which is equivalent to saying only when a "home" semaphore has been passed at danger.

Digitized by Google

In any case the driver has ultimately complete control over his train, and by taking the necessary steps can move against any signal, the inventor's intention being to make action necessary before a signal can be *disobeyed*, instead of action being necessary before a signal can be *obeyed*.

The flexible having been connected up during the following experiments, attention should be concentrated upon the full-size equipment. This will be showing "stop" and "reduce speed" at two of its windows, the bell and horn will sound, and the Control Indicator will show "brake on," "steam off." By pressing buttons the audible signals will cease, and the Control Indicator will show first "brake free" and then also "steam free." Everything is now ready for another run.

(IX.). On pulling over the starting lever the driver receives "clear," and would start his train. On passing a ramp (R2 on the print*) his "reduce speed" signal disappears automatically. We will now arrange the station for a run through on the straight line, set the points for the line, and pull over the admission and starting levers. On approaching the station No. 3 Indicator (white) will fall, indicating that the driver is to run through on the straight. Having read it he will replace it.

(X.). After he has passed through, the loop line will be cleared, and the points set for him to run in on the loop. The starting signal will then be put against the train and the admission lever for it. On reaching the point R on the print he will now receive the signal "reduce speed," his bell will commence to ring, and the red lamp, "steam off," light up; immediately afterwards No. 2 Indicator will fall, showing that he is to enter on the loop line. Having observed this, he will stop the bell, free his steam pipe, and replace his indication.

(XI.). On entering the station, the starting signal being against him, the "stop" signal will fall, both red lamps light up, and the horn commences to sound. The driver will stop, free his brake and steam pipes, and silence his horn ready for the starting signal.

The above it is believed sets forth the main features of the proposed system as it might be applied to ordinary every-day working, and shows the operation of the

Clear
Stop
Reduce Speed
Danger
} Signals.

and of the route indications.

As previously stated, the method of utilizing the "controlled currents" on the engine is capable of variation to suit the system of working considered most suitable for the railway adopting the principle of such control.

* This is as the model has been made. A better situation for the removing ramp would probably be opposite the middle of the platform, so that the "reduce speed" signal may be removed before the driver starts at all.

Digitized by Google

It only remains to point out that similar pairs of "reduce speed" ramps can be placed in any position that may be desired, one of each pair, for the purpose of notifying to the driver and compelling his attention thereto that he is required to reduce his speed over any given section, and the other that he has quitted that section and may again go ahead. The value of such a control on sections of line requiring cautious driving, owing to sharp curves being under repair, etc., is incontestable. Further, it will be a simple matter to add to the engine equipment as shown a recorder which will show the exact time of receipt of every signal and the length of its duration, and thus afford not only a valuable record of the signals received throughout a run, but an accurate check upon the action of the driver on receipt of the special signals, "danger" and "reduce speed."

Digitized by Google

# *NOTICES OF MAGAZINES.*

## Bulletin.

### *15th October*, 1908.

Grand French Manœuvres.—The chief point of interest in these manœuvres was the use of trains of motor-lorries for the purposes of supply. Forty lorries were available, the majority belonging to private firms, who supplied the *personnel*, fuel being furnished by the Government. The H.P. varied from 15 to 50, and the motive power was petrol, steam, or alcohol. The convoys were organized in sections of 10 vehicles, each under an officer. The experiment was most successful, a mean speed of 12–15 kilos. per hour being kept up without any serious breakdown over a distance of 130 kilos. The number closes by a continuation of a study on German field artillery tactics.

### *31st October*, 1908.

Organization of Colonial Troops.—A detailed account of the Colonial forces of France, Germany, Italy, Holland, and Great Britain.

International Law. Russo-Japanese War (*continued*).—*Disposal of the Dead.*—Japanese dead were to be cremated, but their hair was cut off and sent to their homes. The enemy's dead were buried. Special instructions were issued to prevent the pillage of the dead both by the army and also by the inhabitants, who were inclined to disinter bodies to rob them. Sentries had to be placed with orders to fire on marauders. It is noted that the burial of the dead after a great battle is a work of considerable labour.

### *15th November*, 1908.

Field Service Regulations, German Army.—*Published 22nd March*, 1908.—As much seems to be expected of the modern German officer as of his British prototype, and the present regulations inculcate every kind of relaxation, from gymnastics and bicycling to winter essays and war games. Stress is laid on exercises with troops of all arms on a war footing, and the importance of night operations is referred to. The training of officers and men should be such as to develop initiative; inaction is condemned as a far greater fault than errors of judgment. As to cavalry, its normal action is offensive, and the enemy's mounted forces must be sought out and rendered ineffective as early as possible. When charged with

Digitized by Google

reconnaissance, it should form a body independent in action and command.

INTERNATIONAL LAW. RUSSO-JAPANESE WAR (*continued*).—*Disposal of Dead Bodies.*—In the interests of sanitation cremation was occasionally resorted to in the case of the Russian bodies—notably at Port Arthur—and on other occasions when the frozen condition of the ground made interment impossible. Identification of the opponent's dead is not explicitly prescribed, but badges of identity must be collected and preserved, if such exist.

*Rifle Bullets.*—On both sides allegations were made as to the use of expanding bullets; these were almost invariably found to be groundless—an ordinary ricochet hit often producing a wound similar to that caused by an expanding bullet. The Russian rifle was of a slightly larger calibre than the Japanese, and it was found that wounds caused by the latter were more quickly cured than those caused by Russian bullets; on the other hand, higher penetrative power often does greater damage.

*The Summons to Surrender.*—All means of bringing an opponent to surrender are recognized as lawful. The Japanese frequently made use of inciting proclamations, notably at Port Arthur, where, also, graphic postcards depicting the happy life of prisoners of war in Japan were sown broadcast by means of a wooden cannon.

*The Siege and Bombardment of Port Arthur.*—Strict orders were issued that the hoisting of the white flag, either by a single fort or by the whole fortress, was not to be taken as a signal to cease fire until special orders had been given. The bearer of a flag of truce must not however be fired on.

GERMAN FIELD ARTILLERY TACTICS (*continued*).

'E.R.'

---

KRIEGSTECHNISCHE ZEITSCHRIFT.

*August*, 1908.

The question of automobile artillery is discussed, and a good description is given of the English Maxim-carrying autocar at Whale Island. The distinction is clearly drawn between this light type of self-propelled artillery, and what are really movable forts—such as Capt. Dayton's automobile fort (U.S.A.) and the armoured vehicle of the 1st Sussex R.G.A. The latter type is indeed merely a light armoured train which dispenses with rails.

It is suggested that a more practical use of a motor engine would be to replace the limber of a gun by a motor car of some species, and it is pointed out that this innovation would greatly reduce the length of columns on the road.

Digitized by Google

A description is also given and three plates of a new self-propelled transport wagon, made by the Swiss firm Soller, of Bâle. This car is of a new type, and, instead of a strong touring engine on a wagon chassis, consists of a wagon engine and wagon chassis. It is a one-cylinder motor, and thus lays claim to extreme simplicity combined with durability —two essential qualities for anything to be used in the field. It does not require a trained chauffeur, as it can be driven by any transport soldier.

The question of dirigible balloons and their influence on tactics is discussed. Although tactics move slowly, yet we are forced to recognize in the mechanically propelled airship, a new arm which will form the reconnoitring force of the future. Its duty, like that of the present strategical cavalry, will be strategical reconnaissance and the destruction of important tunnels and railway lines. The latter task will not be accomplished by projectiles thrown from the airship, which will merely serve as a means of transport for the necessary men and materials for the task. That encounters will take place between the hostile balloon squadrons—or even single balloons—is hinted at, but no suggestions are offered as to how these should be carried out. Whether strategical balloon reconnaissance of a country before the outbreak of war is permissible or not is a delicate diplomatic question which remains to be solved. Finally, it is stated that a balloon is of little use unless joined to the headquarters staff by some form of wireless telegraphy unreadable to the enemy.

A review of the new German manual of military engineering (*Feldbefestigungs-Vorschrift*) is given under the heading of "Technics in Field Warfare."

The book is considered under three heads:—(*a*). The reasons why a new edition was published. (*b*). New principles. (*c*). New details for individual arms.

As regards the first point of view, the reasons given are:—(1). The increased importance of fortress warfare as exemplified by the semi-permanent character of the Battles of Liao-yang and Mukden. (2). The introduction of the new recoiling field gun and the increased importance of machine guns and heavy artillery. (3). It was 13 years since the last manual had been edited.

Under (*b*) it is stated that there are no new principles, but various more or less old ones are emphasized, *e.g.*:—(1). The spade is as much a weapon as either gun or rifle. (2). The artillery is the backbone of any operation (Moltke). (3). The principle of one defensive line is adhered to, reinforced by means of obstacles and false fronts. A net distinction is however drawn between a position for the active or offensive-defensive and one for the passive-defensive. (4). The enemy must not be waited for, digging must be commenced as soon as possible. (5). Trenches are always for troops standing, except in exceptional cases. (6). The troops are to fortify their own portion of the defensive

Digitized by Google

line, the sappers being used to supervise and not actually dig the works.

Under the third heading are given the dimensions and types of trenches to be used by infantry, machine guns, heavy and field artillery, and howitzers. Although the latter will generally fight from concealed positions, yet freshly turned-up earth must be covered for concealment against observation from balloons. Finally, the special duties of pioneers and engineers are laid down.

A. H. SCOTT.

---

## MILITÄRISCHE PRESSE.

*Vienna, 3rd October*, 1908.

The first number of this new Service illustrated weekly, which is published in Vienna, affords ample justification for the hopes expressed in the editor's foreword that it will not only furnish instructive articles for the professional soldier, but will prove to be of value to all those who are interested in any way with military and naval matters. The circle of readers of a paper of this description would undoubtedly be wider in a country where the fundamental idea of the citizens' military duty is already firmly established than it would be in our own, but even in England the advent of such a paper would help many to realize the military responsibilities of citizenship.

During the course of each month the editor proposes to publish technical supplements dealing with artillery, naval, tactical matters, and with the technical branches. The naval supplement appears with the first number, and its leading article deals with the question of the value of a fleet to Austria. As example of the importance of local command of the sea, the writer draws attention to the Russo-Japanese War, and then proceeds to sketch the growth of England's trade, which was only rendered possible by her maritime supremacy during the last hundred years.

Austria-Hungary formerly preserved the character of a country cut off from maritime trade through its geographical position, and this influenced its historical development. The Dalmatian Coast and Istria only came into the undisputed possession of the monarchy when it had almost lost its importance in the West in consequence of the altered conditions of communications. The writer attributes to this the failure of his nation to grasp the importance of maritime trade, while other countries closely connected with the sea recognized this importance and developed their industries with this in view. He dates his country's awakening to the opening of the Suez Canal, which offered advantages to developing trade in the Adriatic. Austria has started far behind other countries, but by the development of her ports during the last few

Digitized by Google

decades she has done much to make good the neglect of former centuries. Her object must now be to build up her sea connection, improve her harbours, increase the means of communication, and construct a suitable tariff policy.

The development of the mercantile marine has been considerable, but the lack of an adequate naval force to defend it and to prevent blockade will seriously affect not only the ports, but the centres of industry throughout the country. The enemy's ships must of course stop at the coast line, but "the armoured hand of naval supremacy reaches far inland beyond the coast line and grips at the very vitals of the country." As the Austrian Navy, by reason of the tasks falling to her in home waters, cannot spare the necessary ships for effective representation overseas, the writer states that Austrian commercial and political influence is waning. Without armoured cruisers, the means of preserving the prestige of her representatives in distant waters is lacking. Austria therefore wants a fleet equal to this task on account of its peace mission alone, and if the question of war is considered, it must be admitted that her fleet has fallen considerably below the other 2nd class navies. The importance of her trade interests and the intensity of a possible hostile attack provides the standard for the necessary navy and mercantile marine.

Security for the strengthening of her world trade is offered only by a strong fleet.

In an interesting article on the efforts of German colonization in the Pacific, by a German naval officer, attention is drawn to the dislike of the Labour Party in Australia to the German workman, who, it is said, is feared on account of his frugality. South Australia is an exception, where in certain localities the German element is to be found in large numbers. In other Australian states however the Teuton settler "unfortunately" turns into an English colonial in a terribly short space of time. The writer considers that this "fear, which produces such an unfriendly and sometimes spiteful tone," cannot be only a fear of German competition in the labour market, but that the Australian politically fears the German colonists as neighbours.

The writer describes briefly the manner in which Samoa, New Guinea, and the other German colonies came into their hands, and the rest of the article is chiefly "puff" of German colonial government, painting such a glowing picture that the editor in a note is constrained to the opinion that the conditions are so easy as to offer Austria-Hungary opportunity for competition.

In an article on the conquest in the air the advantages are put forward of combining the systems of balloons and aeroplanes, and it is urged that for one Zeppelin balloon, with two sheds, 20 small "air automobiles" for two persons each or six "air omnibuses" for 20 persons each can be constructed, and that in case of war a single small "air automobile" will destroy half-a-dozen of the giant balloons in the air.

E. G. Wace.

Digitized by Google

### NEUE MILITÄRISCHE BLÄTTER.

The issues of the 12th and 16th October, 1908, contain a description of our 1908 manœuvres. The writer makes only a passing mention of the cavalry manœuvres, as they have been described and criticized in detail in the *Militär Wochenblatt*, but he ventures on the remark that the results of the training of the cavalry division were considerably overestimated by the English press, and that the praise bestowed on the work performed and the tactical training of the regiments, "can well be described as extravagant."

Referring to the cancellation of the manœuvres of the 3rd and 4th Divisions, the writer of the article observes that public opinion was at first considerably agitated, owing to the report that unexpected bad news from India necessitated the preparation of both these divisions for a possible immediate departure. The real cause of the abandonment of these manœuvres is however stated, and "the public mind was set at rest" when it was observed that the Aldershot command manœuvres commenced according to programme. The general idea is given, and the writer then proceeds to describe the capture of Colonel Gough's cavalry force. He has no more to say about the events of the first four days (13th to 16th September), but remarks that the operations were more realistic than formerly, though unrealities were still to be found. Red's lame attack on the 15th September in difficult country, which ought to have been declared by the umpire staff to be impossible, and Blue cavalry's loss of touch with the enemy, which caused General Grierson's advance to be made in a wrong direction, "etc," are quoted in support of the statement. The events of the last three days are similarly lightly touched upon, and serve only to introduce the comments which appear to have been framed in Germany and not in England. They were apparently based on the accounts in the *Army and Navy Gazette* and the *United Service Gazette* (? magazine), which are freely quoted, but characterized by the critic as "high flown." After these quotations the writer of the article proceeds:—"The cause of peace is certainly not served by such almost comical exaggeration with respect to the capabilities of an army, which—in spite of however much individual ability and bravery it may contain—is, according to the unanimous judgment of Europe, only to be reckoned as very 'middling,' when taken as a whole and regarded as a weapon of war. The war party in the country . . . as well as the '*entente*' fanatics in France, derive therefrom only a fresh impulse, and the waverers are encouraged to allow themselves to be won over." The writer concludes by saying that it is therefore no surprise to find Mr. Carnegie's famous appeal to the German Emperor to finally establish universal peace by an alliance with Great Britain, France, and the U.S. of America scornfully answered.

Brief articles appear in the issues of the 16th and 24th October on the military forces of Turkey, Bulgaria, Servia, and Montenegro. These have an especial interest in view of recent political events. Referring to the Turkish Army, the writer of the article gives some numerical details,

Digitized by Google

and proceeds to observe that almost nothing is known of the number and organization of the army corps to be formed in the event of war, as no *ordre de bataille* exists. The whole of the military forces of Turkey are estimated at 1½ millions, of whom, in the most favourable circumstances, only a half can be counted on for a European campaign. Only the three strong army corps in Constantinople (the Guard), Adrianople, and Salonika were available in case of the possible immediate operations in the Balkans. The cavalry are deficient in horses and the artillery deficient in guns. The infantry is armed with three different kinds of rifle, viz., the Mauser, Martini-Henry, and the Peadbody. The cavalry have different models of carbines, while the artillery have got mostly 75 mm. Krupp quick-firing guns.

After detailing the strength of the Bulgarian Army, the total of which he puts at 354,000, the writer points out that the infantry is armed with the Austrian Mannlicher rifle and the cavalry with Mannlicher carbines. "The former difficulties in the way of obtaining remounts have been regarded as overcome by the recent introduction of Hungarian horses. The equipment is extraordinarily practical, the officers good, and, like the men, are, to all appearance, excellently trained."

The Servian Army is composed of three levies (Bans), the first two of which are estimated at an outside total of 150,000 rifles, 6,000 horse, 264 field and 42 mountain guns, 22 howitzers, and about 100 siege pieces. The 3rd Ban can, according to the writer, only be used for garrisons and lines of communications. The training of the army is deficient by reason of the short time the men are with the colours, which, although nominally 1½ to 2 years, is actually not more than 15 months for mounted and 10 months for dismounted. The officers are said not to be up to modern requirements, appear unreliable, politically divided, and torn by party passions.

The Montenegrin Army, on mobilization, numbers about 35,000 in 1st Line and about 15,000 in 2nd Line, which consists of men from 46 to 60 years of age. The infantry is armed with several different kinds of rifles; the artillery have 18 new 7·5-cm. Krupp field guns, 36 old Krupp cannon, 30 mountain guns, 2 15-cm. mortars, and 4 12-cm. siege pieces.

The issue of 16th October contains an article on the great French manœuvres, which ended on 18th September. Attention is drawn to the arrangements made for the work on the lines of communication. A mechanical transport "park" of 80 vehicles undertook the replenishment of provisions for the VIII. and IX. Corps of the "Trémean" force, while both cavalry divisions of the "Millet" force carried out the reception of provisions at reception stations from routes manned under service conditions with the nucleus of "mobile authorities." The writer praises the advance made in these manœuvres towards the realization of service conditions, and says they (the Germans) are forced to realize that in a possible conflict they would in any case no longer find "the old Frenchmen," and then proceeds to say that the French infantry is a weapon schooled on sound lines for modern war; the lightening of their pack has increased their already good marching powers; they turn to excellent

Digitized by Google

advantage the accidents of the ground, are quick and adept at entrenching, almost always choose the most suitable formations, and evince excellent discipline. In addition to this the close co-operation of the infantry and artillery—an indispensable condition of success in modern fighting—was a very noticeable point in their training, and one in which the writer considers the Germans are a long way behind the French. The writer however finds fault with the work of the French cavalry, which he considers lacking in dash. He observes that even in Napoleon's time the French cavalry soldier was a bad horse manager, and that he seems to have remained true to this tradition.

In the issue of 24th October appears an article on the introduction of universal military service in Australia, in which the writer observes that "the widespread secret fear of Japanese attack threatening in the future, together with the bad results experienced under the volunteer system (their number only amounted to 20,000 out of 800,000 male inhabitants), convinced the nation of the necessity of a better and much more extensive organization for defence." The scheme is briefly described, and particular attention is drawn to the consideration given to married men, who are not called out in case of war until the 1st and 2nd Classes, *i.e.*, unmarried men from 18 to 35 and from 35 to 45 years of age respectively, have been found insufficient for the occasion. It is also noticed that the new law enables the Commonwealth to arrange for field artillery on a regular basis, instead of on a militia basis with the other arms.

The opinion is expressed that the minimum period of training allowed by the scheme will not be able to produce a really efficient (*leistungsfähiges*) army of defence, especially against the Japanese, and this has not been understood by a nation "which has grown up in antiquated British ideas regarding the military value of a militia army."

E. G. WACE.

---

## REVISTA DE ENGENHERIA MILITAR.

*July and August*, 1908.

FORTIFICATION FOR HOME DEFENCE.—A lecture delivered to the Regiment of Engineers by Lieut. R. A. Esteves. After a short summary of the campaigns from the time of the war of the Spanish Succession down to that of the Peninsular, the author proceeds to consider the three courses of action which it is possible to take in the defence of the country, viz. :—(1), To await the enemy on the frontier; (2), to invade the hostile territories; and (3), to await the enemy in the interior of the country.

He comes to the conclusion that in view of the small force which would be available, the third course is the only one which could be adopted.

Digitized by Google

The frontier should be defended by barrier forts placed on the main lines of invasion, and the enemy should be delayed as long as possible on the frontier, so that time may be gained for mobilization, and for the organization of the defensive position. The troops would then fall back from the frontier, first onto the lines of the Mondego and Zezere, which would be strengthened by the fortifications of Coimbra, Tancos, and Santarem, and finally on the lines of Torres Vedras, which must always form the last stronghold of the defence of Portugal.

Provisional works should be constructed at Coimbra, Tancos, and Santarem, forming entrenched camps which would be used as bases for offensive operations against the flank of an enemy advancing against the capital. It would not however be possible to hold them to the last, and the army must be prepared eventually to retire within the lines of Torres Vedras. These latter consist of a triple line of fortifications resting on the sea on one side, and on the Tagus on the other. The so-called entrenched camp of Lisbon forms the third or inner line.

The enemy in advancing against the outer line would be compelled to divide his forces into two parts, by the configuration of the Serra do Montejunto which runs perpendicularly to that line.

The hills which form the successive lines are naturally strong and difficult of access, so that the fortifications should be concentrated at those points which block the passage of the defiles. The remaining works should be disposed in such a manner as to favour counter-attack.

Under modern conditions it is necessary that the lines of Torres Vedras should be supplemented by fortifications on the south bank of the Tagus; this line should run through Moita, Palmella, and Setubel, and its defence should be combined with the maritime defence of the port of Setubel. In fact the whole land defence should be most intimately connected with the maritime defences, for the sea must be looked upon as the true base from which Portugal would draw the supplies and reinforcements which would enable her to carry on the campaign.—(*To be continued*).

METOL AND HYDROQUINONE.—By Lieut. Jayme Pinto.—This is a long article on the value of these substances as developers in photographic work. It does not appear to contain any novelty, though it will be of considerable use to many amateur photographers.

HARMONIC SYNTHESIS OF THE TIDES (*continued*).

SOME PROJECTS AND WORKS EXECUTED IN THE PROVINCE OF MOÇAMBIQUE.—This instalment contains a description of the construction of the lighthouse at Macuty, and is illustrated by several photographs, as well as by detailed diagrams of the Chance lamps and lenses.

REVIEWS OF BOOKS.—*Hypsometric Map of Portugal.*—This map, of a scale of 1:500,000, was published by the Geological Commission in 1906.

'M.'

Digitized by Google

## REVUE DU GÉNIE MILITAIRE.

*September*, 1908.

WELLS IN SENEGAL.—The district between the Senegal and Gambia Rivers is devoid of surface water during the dry season. The tribes inhabiting this region are therefore compelled to wander long distances with their cattle in search of water. As long as they are nomads they remain uncivilized and the development of the country is impossible. The first work to be done therefore is the construction of permanent wells, to form the starting point for permanent settlements. For the most part the soil is sandy and treacherous and the native wells rarely survive a rainy season. The French have tried various methods of lining wells, and have finally rejected all others in favour of ferro-concrete, 2″ thick, made on ·16″ iron wire lattice-work of 4″ mesh. This lining can either be sunk on a curb or constructed *in situ*, as the nature of the soil demands. When a solid stratum is passed through, material is economized by reducing the thickness of the ferro-concrete from 2″ to ½″. A well is sunk in this way by a gang of four natives, visited once a day by an European overseer.

THE FOREIGN MILITARY ESTABLISHMENTS IN CHINA.—The conclusion of the previous articles. The Italian, Russian, American, Dutch, and Belgian barracks are dealt with in this number. They call for no special notice.

*October*, 1908.

FOUNDATIONS OF BARRACKS AT AVIGNON.—The subsoil at the site of the barracks consists of treacherous, waterlogged clay, and sand. At a depth of 14′ a solid bed of gravel was found. The foundations were made by sinking a number of large bore-holes down to the gravel. These were afterwards filled in with concrete, and joined together at the top with concrete arches. A heavy boring tool actuated by a pile-driver was used. The tool consisted of a steel cone 27″ in diameter at the base and weighing 3,300 lbs. The concrete was mixed dry and rammed by another heavy tool. Each well took only from 40 minutes to an hour to sink; the filling in and ramming took from three to three and a-half hours. The barracks were finished in December, 1904, and so far the foundations show no sign of settlement.

The reproduction of plans by electric light is also dealt with in an article which consists of a description of various electric lamps and apparatus used for printing photographically from plans and tracings.

J. E. E. CRASTER.

Digitized by Google

## Revue Militaire des Armées Étrangères.

*October*, 1908.

The narrative of the Russo-Japanese War is continued, the portion described being the operations of July, 1904.

A review of the new German Felddienst-Ordnung of March, 1908, is given with comments.

The history of the military ballooning troops in Germany (Luftschiffer-Batallion) forms the subject of an article which also describes the "Drachenballon" used by the Germans for captive ascents. The advantage claimed by this particular form of balloon over the round type is that the car remains still whilst in the air and thus facilitates observation. The balloon, which is cylindrical with hemispherical ends, is divided internally into two parts by a membrane. The gas in one of these expands as the balloon rises—thus nearly filling the whole envelope. When however the pressure becomes too great a cord attached to the movable membrane opens a valve, thus avoiding all risk of explosion. This balloon also has a rudder (stewersack) at the rear of the balloon, composed of a bag filled with air and provided with a valve, and a tail (Drachenschwanz), or rope, carrying hollow frustra of cones, whose larger base is turned in the direction of the wind.

The Luftschiffer-Batallion consists of three companies, one of which is for experimental purposes; 15 lieutenants are annually attached to it to receive instruction.

The Schwarzlose machine gun which has been adopted by the Austrian Government is described. Its chief advantage is the small number of moving parts of the lock (11) and spring (1) as for example compared with the Maxim, which has 35 and 14 parts respectively.

The rate of fire is 400 rounds per minute, maximum range 2,400 yards, and angle of lateral dispersion 35°. 10,000 rounds per gun are carried by the infantry and 15,000 per gun by the cavalry. The infantry gun only is provided with a khaki-coloured steel shield, which is covered by a green cloth when firing in front of a dark background.

The organization and probable war strength of the Turkish Army in Europe is given:—

(*a*). 1st Army Corps (Ordou), Constantinople.
1st and 2nd Infantry Divisions (Nizam), 25 battalions.
1st Cavalry Division (Nizam), 32 squadrons.
1st Artillery Division (Nizam), 39 batteries.
1st, 2nd, and 3rd Divisions (1st Class Redif), Asia Minor, 64 battalions and 16 squadrons.
Nizam means 1st line troops, Redif reserve.

Digitized by Google

(*b*). 2nd Army Corps, Adrianople (Thrace).
3rd, 4th, 20th, and 21st Infantry Divisions (Nizam), 52 battalions.
2nd Cavalry Division (Nizam), 35 squadrons.
2nd Artillery Division (Nizam), 53 batteries.
6th, 7th, and 8th 1st Class Redif Divisions (Asia Minor), 48 battalions and 12 squadrons.
25th and 26th 2nd Class Redif Divisions (Thrace), 40 battalions.

(*c*). 3rd Army Corps, Saloniki (Macedonia), 5th, 6th, 9th, 17th, 18th, 22nd, and 23rd Infantry Divisions (Nizam), and the 47th Infantry Brigade (Nizam), *i.e.*, $7\frac{1}{2}$ divisions or 126 battalions.
3rd Cavalry Division (Nizam), 47 squadrons.
3rd Artillery Division (Nizam), 55 batteries.
12th Division and 22nd Brigade (1st Class Redif), Asia Minor, 24 battalions and 16 squadrons.
28th, 29th, 30th, 31st, 32nd, 33rd, and 34th 2nd Class Redif Divisions (Macedonia), 120 battalions.

Thus there are in Europe 203 battalions, 114 squadrons, 147 batteries of the permanent or 1st Line troops, and 160 reserve battalions (2nd Class Redif).

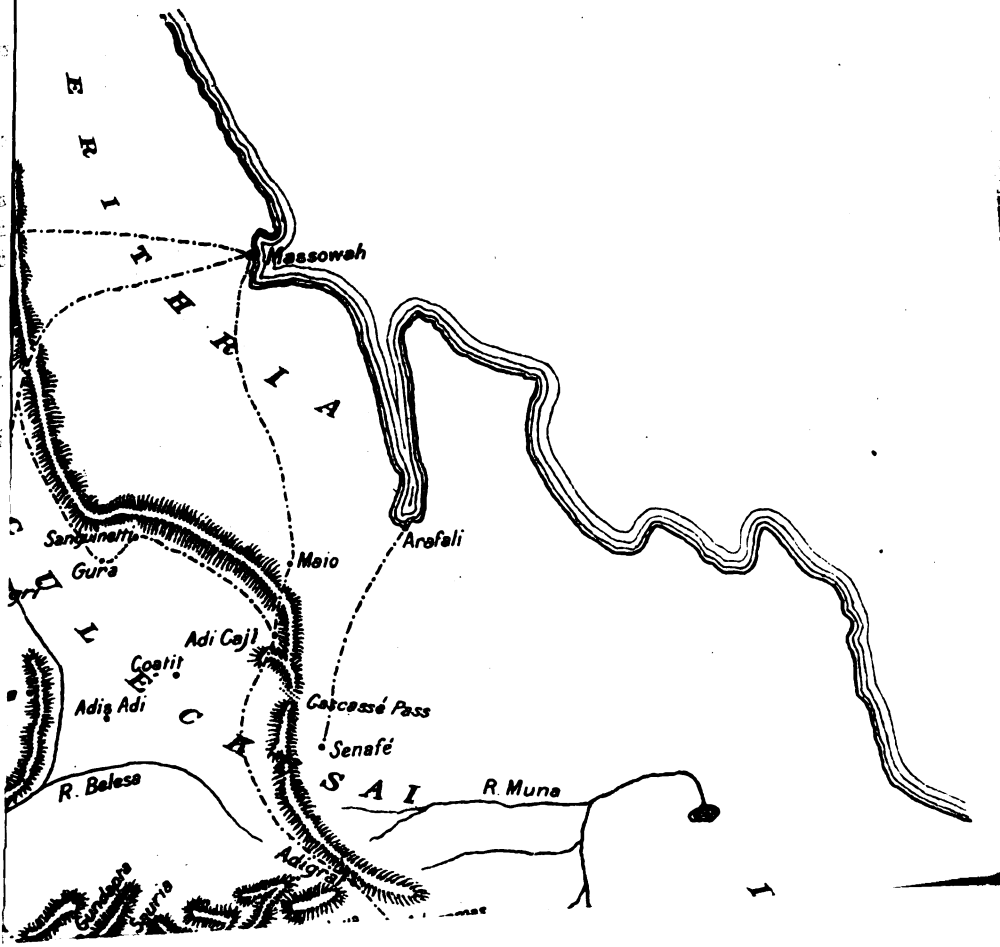
In Asia Minor 136 battalions and 44 squadrons of the 1st Class Redif or reserve.

A battalion at war strength is 800 strong and a squadron 150.

A. H. SCOTT.

Digitized by Google

# HE ITALIAN OPERATIONS IN
# EN THE YEARS 1894 & 1896.




Digitized by Google

Digitized by Google

SOME PUBLICATIONS BY

# THE ROYAL ENGINEERS INSTITUTE.

| Title and Author. | | | Net Price to Non-Members. |
|---|---|---|---|
| | | | s. d. |
| **R.E. Field Service Pocket-Book.** 2nd Edition | 3″ × 5″ | 1902 | 5 0 |
| **The Destruction of Mosquitos,** being an Account of the Drainage and other works carried out with this object during 1902 and 1903 at St. Lucia, West Indies, by Major W. M. Hodder, R.E. | | 1904 | 2 6 |
| **Notes for Officers Proceeding to India.** Compiled by Major A. T. Moore, R.E. (Part I. Outfit, Servants, Amusements, Health, Hints for Ladies, etc.; Part II. Physical Features, Administration, Native Army, History, Languages, Castes, Religions, etc.; Appendix. Shooting Hints) | | 1904 | 2 6 |
| **Detailed History of the Railways in the South African War, 1899—1902.** 2 vols. (Vol. I. Organisation, Military Control, Working and Repair of Cape and Natal Government Railways; Management, Engineering and other Departments of Imperial Military Railways; Railway Pioneer Regiment; Organisation, Equipment and Use of Armoured Trains; Army Labour Depôts; pp. xli. and 275. Vol. II. 61 Photos and 93 Drawings) | Folio | 1904 | 42 0 |
| **The Franco-German War, 1870—1871.** Condensed from the German of Major J. Scheibert, and translated by Major J. A. Ferrier, D.S.O., R.E., and Mrs. Ferrier | | 1894 | 7 6 |
| **The Principles of Structural Design,** by Major G. K. Scott-Moncrieff, R.E., Assoc. Inst. C.E. 2 vols. (663 pp.; 30 Plates and numerous Figures) | | 1897 | 10 6 |
| **The Water Supply of Barracks and Cantonments,** by Major G. K. Scott-Moncrieff, R.E., Assoc. Inst. C.E. (311 pp.; 60 Plates and numerous Figures) | | 1896 | 10 6 |
| **Notes on Blacksmith's Work,** by Major R. F. Sorsbie, R.E. | | 1903 | 4 6 |
| **History of the Corps of Royal Engineers,** by Major-Gen. Whitworth Porter, R.E. 2 vols. | 9″ × 5½″ | 1889 | 5 6 |
| **Professional Papers of the Corps of Royal Engineers.** Occasional Papers Series. Vols. I. to XXX., 1877—1904. (Separate Papers at various prices) | each volume | | 10 6 |
| Fourth Series. Papers 1 to 7, 1905—1907; Papers 1 and 2, 1908. (Royal Octavo, 9″ × 6″). Various prices. | | | |

Except where otherwise stated, the books are octavo, measuring 8½″ × 5½″.

They may be obtained from Messrs. W. & J. Mackay & Co., Ltd., Chatham, or from any Bookseller.

Digitized by Google

# MR. E. CARLISLE, M.A. (Cantab.),

AND

# MAJOR M. H. GREGSON, late R.E.,

Prepare Candidates for all Army and Civil Service Examinations at

## 5 & 7, LEXHAM GARDENS, KENSINGTON, W.

We have retained the services of all the Tutors who have been so remarkably successful in past years, and continue to receive both resident and non-resident candidates.

---

**Recent Successes Include:—**

## STAFF COLLEGE, AUGUST, 1908.

The following Officers, whose names are arranged in regimental order, were successful from us at the recent Competitive Examination for admission to the Staff College:—

Capt. A. F. Home, 11th Hussars.
,, J. Knowles, 15th Hussars.
,, C. R. Newman, Royal Field Artillery.
,, P. E. Lewis, Royal Field Artillery.
,, M. H. C. Bird, Royal Garrison Artillery.
,, A. F. U. Green, Royal Garrison Artillery.
,, C. G. Fuller, Royal Engineers.
,, G. R. Frith, Royal Engineers.
,, T. C. Mudie, Royal Scots.
,, I. L. B. Vesey, Royal West Surrey Regiment.
,, H. G. A. Thomson, Royal Warwickshire Regiment.
,, E. T. Humphreys, Lancashire Fusiliers.
Capt. D. S. Robertson, Royal Scots Fusiliers.
,, H. L. Alexander, Dorsetshire Regiment.
Lieut. A. P. Wavell, Royal Highlanders.
Capt. H. C. Johnson, D.S.O., King's Royal Rifle Corps.
,, R. M. Tyler, Durham Light Infantry.
Lieut. A. J. McCulloch, Highland Light Infantry.
Capt. L. C. Sprague, Royal Irish Rifles.
Capt. L. F. Renny, Royal Dublin Fusiliers.
Lieut. C. M. Davies, Rifle Brigade.
Capt. R. D. Barbor, Army Service Corps.
,, C. L. Norman, M.V.O., Indian Army.
,, G. L. Pepys, Indian Army.

The following obtained nominations:—

Major S. R. Kirby, 6th Dragoon Guards.
Capt. R. Hutchison, 11th Hussars.
,, E. F. Calthrop, Royal Field Artillery.
,, and Bt. Maj. A. J. Turner, Royal Field Artillery.
,, and Bt. Maj. C. B. Thomson, Royal Engineers.
,, and Bt. Maj. A. J. G. Moir, Royal Scots.
,, and Bt. Maj. A. McN. Dykes, Royal Lancaster Regiment.
,, A. D. Green, D.S.O., Worcestershire Regiment.
,, T. H. C. Nunn, D.S.O., Royal West Kent Regiment.
,, H. L. Knight, Royal Irish Fusiliers.

---

## WOOLWICH.

### June, 1908.

| | | |
|---|---|---|
| THIRD | G. B. Stallard | 7,629 |
| 22nd | L. F. Page | 6,564 |
| 23rd | G. E. W. Franklyn | 6,559 |
| 29th | G. A. Cammell | 6,437 |

### November, 1907.

| | | |
|---|---|---|
| THIRD | F. N. M. Mason | 7,441 |
| FIFTH | E. J. Moorhead | 7,236 |
| SIXTH | C. W. R. Tuke | 7,166 |
| 24th | J. R. Pinsent | 6,493 |
| 27th | H. W. Crippin | 6,411 |
| 32nd | L. H. King-Harman | 6,372 |
| 35th | R. B. Pargiter | 6,339 |

This is the second time in two years we have passed THREE out of the first SIX for Woolwich.

## SANDHURST.

### June, 1908.

| | | |
|---|---|---|
| FOURTH | H. T. Rohde | 5,307 |
| 27th | W. G. Maxwell | 4,937 |
| 44th | H. L. Mood | 4,775 |
| 45th | H. S. F. Cosens | 4,761 |
| 79th | J. M. Ponsford | 4,473 |
| 89th | B. H. Bonham-Carter | 4,399 |
| 105th | L. B. Rundall | 4,312 |
| 127th | J. A. Batten-Pooll | 4,183 |
| 161st | A. E. Lawrence | 3,985 |
| 162nd | M. Alexander | 3,981 |
| 167th | R. W. Russell | 3,940 |
| 171st | G. W. Mackintosh | 3,897 |
| 191st | R. H. Broome | 3,733 |
| — | C. S. Hilton* | 3,563 |
| — | W. N. Shipster* | 3,221 |
| — | J. V. Dawson* | 3,148 |

*Subsequently admitted.

---

## INDIAN POLICE, JUNE, 1907.

| | | | | | |
|---|---|---|---|---|---|
| THIRD | F. W. Toms | 6,886 | 27th | H. W. Waite | 5,980 |

---

## ARMY QUALIFYING, SEPTEMBER, 1908.

NINE were successful from us.

---

## MILITIA COMPETITIVE EXAMINATION, MARCH, 1908.

Douglas Scott, Kent Artillery.
D. G. Gunn, 3rd P.W.O. West Yorkshire Regt.
A. L. Cooper Key, 5th Middlesex Regiment.
W. C. Loder Symonds, Lancashire Fd. Artillery.
R. G. Atkinson, West Surrey Regiment.
R. W. Leach, Cambridge Volunteers.
G. W. Courtney, Cork R.G.A.

Digitized by Google

# THE ROYAL ENGINEERS JOURNAL.

Vol. IX. No. 2. FEBRUARY, 1909.

## CONTENTS.


| | | Page. |
|---|---|---|
| 1. | **Search Lights in Field Operations.** By Capt. R. WALKER. (*With Photos*) ... | 81 |
| 2. | **Notes on Reinforced Concrete** *versus* **Wood.** By Major A. H. D. RIACH, R.E. (*With Plates*) ... ... ... ... ... ... | 89 |
| 3. | **Modern Sewage Disposal.** By Capt. and Hon. Major G. B. WILLIAMS, R.E. (T.). (*With Plates*) ... ... ... ... ... ... | 107 |
| 4. | **The R.E. Headquarter Mess** (*continued*). By Lt.-Col. B. R. WARD, R.E. ... | 129 |
| 5. | **Transcripts:**—The Electrical Supply of Geneva. (Translated from *Notes et croquis techniques sur Genève* by 2nd Lieut. A. H. SCOTT, R.E.) ... | 137 |
| | The Protection of the Railway in Trans-Amur. (Translated from the *Voënnyi Sbórnik* by Capt. A. H. BELL, R.E.). ... ... | 141 |
| 6. | **Notices of Magazines** ... ... ... ... ... ... | 144 |
| 7. | **Correspondence:**—A Mechanically Operated Flare. By Capt. W. G. S. DOBBIE, R.E. | 164 |


CHATHAM:
ROYAL ENGINEERS INSTITUTE.
AGENTS AND PRINTERS: W. & J. MACKAY & CO., LTD.

PRICE: 1s. 6d. POST FREE. ANNUAL SUBSCRIPTION: 15s. PAID IN ADVANCE.

Digitized by Google

THE MODERN ROOFING MATERIAL,

# "ETERNIT."

ROOFING SLATES.

SHEETS FOR WALLS AND CEILINGS.

INDESTRUCTIBLE, LIGHT, ARTISTIC, ECONOMICAL, WEATHERPROOF.

Weight, 22 lbs. Laid.

## G. R. SPEAKER & CO.,

**Engineers & Contractors to H.M. Government,**

**29, MINCING LANE, E.C.**

WIRE—"ETRASHEET." 'PHONE—CENTRAL 13174.

# Royal United Service Institution,

**WHITEHALL, S.W.**

Contains the best professional Library in the United Kingdom; an excellent collection of Maps and Charts; Reading and Smoking Rooms provided with the leading papers, periodicals, and writing materials; a Museum of Naval and Military relics and trophies; and a Theatre in which lectures upon professional subjects, followed by discussions, are frequently given.

## TERMS OF MEMBERSHIP.

**ANNUAL MEMBERS, £1 1 0 on entrance, £1 1 0 annually.**
**LIFE MEMBERS - - - £15 0 0**

Officers whose names appear in the Official Navy and Army Lists become members on payment of the above fees, and applications for membership, giving rank, qualification, and address, should be made to the Secretary.

---

**"THE JOURNAL OF THE ROYAL UNITED SERVICE INSTITUTION."**

This valuable "Journal" is published monthly, and is sent post free to all Members of the Institution; it is also sent regularly each month to all Naval and Military Attachés, and the principal Foreign Embassies and Legations in London; it is also in the hands of and extensively read by Officers in nearly every Army in the World, as well as Officers of our Colonial Forces.

"The R.U.S.I. Journal" is the Official Organ of the above Institution; it contains the Lectures given in the Theatre, Articles on Professional Subjects, important Naval and Military Notes, also fullest particulars of Naval and Military Inventions, Notices of Books, etc.

The Circulation is more than double that of any Service Publication in existence; it has the largest circulation in India, the Colonies, and also on the Continent of any Service Publication published in the English language; it is widely read, and of great Official importance in most Foreign Countries.

Digitized by Google

Telegrams—"GUNDRADA, LONDON." Telephone—4716 Gerrard.

Fire, Theft and Burglary *(Combined).*

THE ARMY, NAVY AND GENERAL ASSURANCE ASSOCIATION, LIMITED

HEAD OFFICE:—217, PICCADILLY (CIRCUS), LONDON, W.

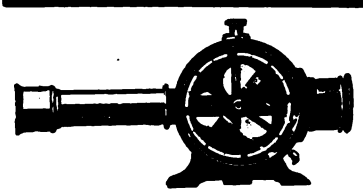
Chargers, Hunters, Marine Risks.

# The "Professional" Policy
. of .
# Accident and Disease Insurance

Is Specially adapted for Military and Naval Officers serving in ANY PART of the WORLD, and now covers 30 Specified Diseases.

**Revised Prospectus of Extended Benefits on application—**

**217, PICCADILLY (CIRCUS), LONDON, W.**



## C. F. CASELLA & CO.,

MAKERS OF

***Surveying & Scientific Instruments***

To the Admiralty, Ordnance and all Home Departments, and to the Indian, Colonial and Foreign Governments.

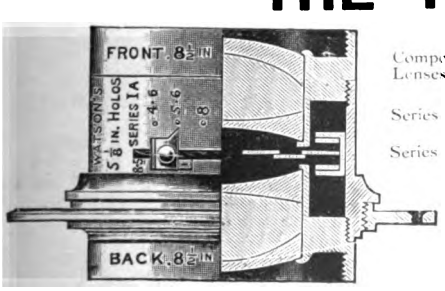
The Illustrations depict CASELLA'S ALTAZIMUTH, a convenient instrument for rough survey work of all kinds.

WRITE FOR PRICE LISTS.

11-15, ROCHESTER ROW, Victoria St., LONDON, S.W.

## THE FINEST PHOTOGRAPHIC LENS
— IS —
## THE HOLOSTIGMAT

*(WATSON CONRADY SYSTEM).*




Composed of two Anastigmatic and Achromatic Single Lenses of perfect correction for use as separate Lenses.

MADE IN THREE SERIES.

Series 1.—Aperture f6 Components f11·5. A perfect Lens for universal use.

Series 1A.—Aperture f4·6. Components f8·5. For rapid work in dull weather.

Series W A.—Aperture f11. Components f16 The ONLY convertible wide angle Lens made.

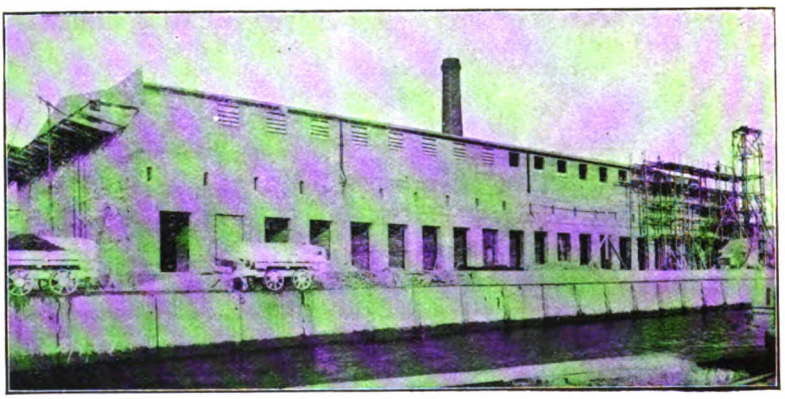
Price List sent FREE, on application, by

**W. WATSON & SONS, Ltd.,**
313, HIGH HOLBORN, LONDON.

Digitized by Google

# EXPANDED METAL

## SYSTEM OF
## REINFORCED CONCRETE
## AND
## FIRE-RESISTING CONSTRUCTION.



EXPANDED STEEL CONCRETE CEMENT STORE FOR THE WOULDHAM CEMENT CO., LTD., WORKS, WEST THURROCK.

### Specialities:—

**CONCRETE REINFORCEMENT**; 3-in. mesh weights Expanded Steel for Foundations, Walls, Floors, Roofs, Bridges, Reservoirs, Sewers Conduits, Hoppers, Silos, etc.

**LATHING FOR PLASTER**; Expanded Metal Lathing for Ceilings, Partitions, Exterior Walls, Steel Work Encasing, etc.

**MADE-UP GOODS**; Openwork Partitions, Fencing, Clothes and Tool Lockers, Machinery and Tree Guards, etc.

*Full particulars on application to:—*

## THE EXPANDED METAL CO., LTD.,

**YORK MANSION, YORK ST., WESTMINSTER, S.W.**

**Telegrams:—"DISTEND, LONDON."** **Telephones:—819 Gerrard; 1514 Victoria.**


Digitized by Google

# PATENT VULCANITE ROOFING

FOR

FLAT ROOFS, CONCRETE ROOFS
AND WOOD ROOFS.

## ROOF TANKS

FOR

SWIMMING-BATHS, RESERVOIRS, BRIDGES.

**EFFICIENT AND ECONOMICAL.**

**For Waterproofing Existing Faulty Concrete and Asphalte Roofs.**

Will give with the movements of the building due to settlement, vibration, and expansion and contraction, and is guaranteed for long periods.

Special surfaces can be provided to the Vulcanite covering to meet any special requirements.

*Full particulars on application to:—*

**VULCANITE, LIMITED, 118, Cannon St., London, E.C.**
**Laganvale, Belfast,** and at **MANCHESTER.**

Also Manufacturers of VULCANITE and BITUMEN Sheetings for the Sloping Roofs of Light Buildings, and for use as a Damp-proof Course).

# BULLIVANT & CO., Ltd.,

Manufacturers of

## *STEEL WIRE ROPES*

FOR

CRANES, LIFTS, HOISTS, SUSPENSION BRIDGES, HAULING, Etc.

**DURABLE AND RELIABLE.**

Contractors for . . . .

## AËRIAL ROPEWAYS

Specially designed for conveying Men and Munitions across Rivers, Ravines, etc. Can be quickly and easily erected and dismantled.

**BLOCKS, PULLEYS, TACKLE, AND ALL WIRE ROPE APPLIANCES.**

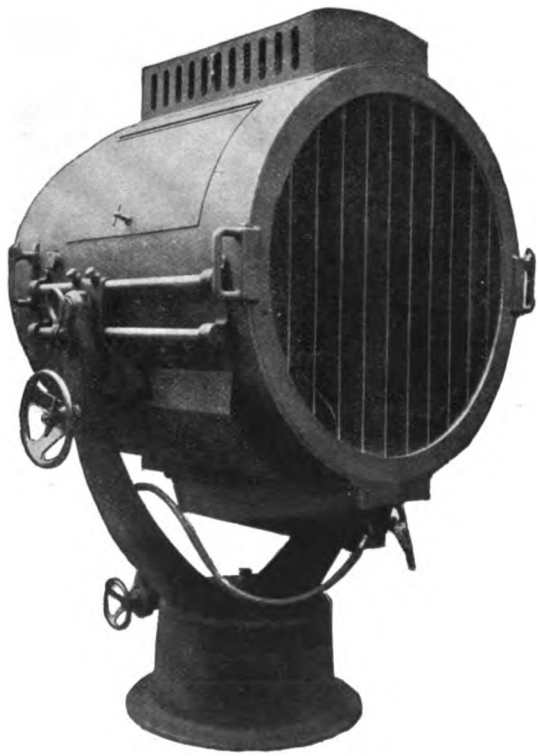
Regd. Office, **72, Mark Lane, London, E.C.**
Works, **Millwall, E.**


Digitized by Google

# SIEMENS
# Searchlight Projectors.

**MADE IN ALL SIZES FROM 25 cm. to 200 cm.**

**For Battleships, Merchant Service, Yachts, River and Suez Canal Navigation.**



**For Fortresses, Field Use, Mining, and all General Land Purposes.**

**Illustration of Class M.P. Projector.**
**60-Centimetre size, with adjustable Trunnions.**

Projectors can be fitted with Siemens' Patent Horizontal Automatic and Hand Lamp, or Horizontal Lamp for hand feed only. Mirrors of the metallic or glass parabolic type. Single or double Dispersing Lenses. Iris Diaphragm Shutter or Venetian Louvred Signalling Shutter. Electric Control is fitted for Fortress, Battleship, and other use, if desired.

**Full Particulars on Application to M Department.**

## SIEMENS BROTHERS DYNAMO WORKS LTD.,

**York Mansion, York Street, Westminster, S.W.**

Telephone: GERRARD 860. Telegrams: "SIEMBRALOS, LONDON.


Digitized by Google

# CONTENTS.


PAGE.

1. SEARCH LIGHTS IN FIELD OPERATIONS. By Capt. R. Walker. (*With Photos*) 81

2. NOTES ON REINFORCED CONCRETE *versus* WOOD. By Major A. H. D. Riach, R.E. (*With Plates*) ... ... .. ... ... ... ... ... 89

3. MODERN SEWAGE DISPOSAL. By Capt. and Hon. Major G. B. Williams, R.E. (T.). (*With Plates*) ... ... ... ... ... ... ... 107

4. THE R.E. HEADQUARTER MESS (*continued*). By Lt.-Col. B R. Ward, R.E. .. 129

5. TRANSCRIPTS :—

The Electrical Supply of Geneva. (Translated from *Notes et croquis techniques sur Genève* by 2nd Lieut. A. H. Scott, R.E.) ... ... ... ... ... 137

The Protection of the Railway in Trans-Amur. (Translated from the *Voënnyi Sbórnik* by Capt. A. H. Bell, R.E.) ... ... ... ... ... ... 141

6. NOTICES OF MAGAZINES : —

*Journal des Sciences Militaires.* By Lieut. H. L. Woodhouse, R.E. ... ... 144
*Nature.* By Major-Gen. W. E. Warrand, D.L., late R.E. ... ... ... 146
*Neue Militärische Blätter.* By Capt. E. G. Wace, R.E. ... ... ... 148
*Revue de l'Armée Belge.* By 2nd Lieut. A. H. Scott, R.E. ... ... ... 150
*Revue du Génie Militaire.* By Capt. J. E. E. Craster, R.E. ... ... ... 153
*Revue Militaire des Armées Étrangères.* By 2nd Lieut. A. H. Scott, R.E. ... 153
*Rivista di Artiglieria e Genio.* By Col. Sir Edwd. T. Thackeray, V.C., K.C.B., late R.E. ... ... ... ... ... .. ... ... ... ... 155
*Voënnyi Sbórnik.* By Capt. A. H. Bell, R.E. ... ... ... ... ... 160

7. CORRESPONDENCE :—

A Mechanically Operated Flare. By Capt. W. G. S. Dobbie, R.E. ... ... 164

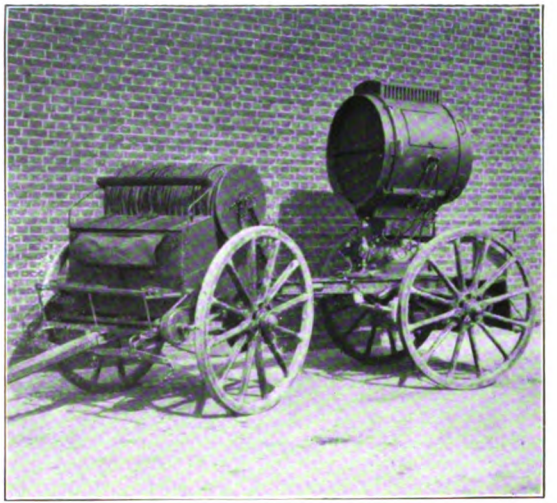

*Authors alone are responsible for the statements made and the opinions expressed in their papers.*

Digitized by Google

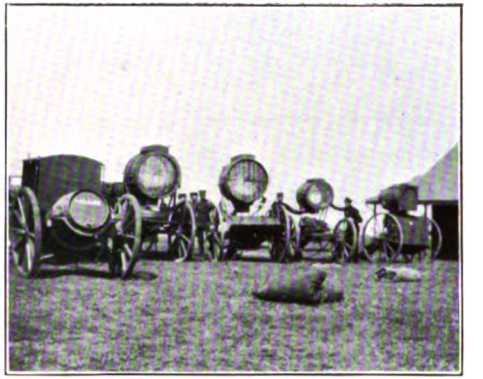
Digitized by Google

Digitized by Google

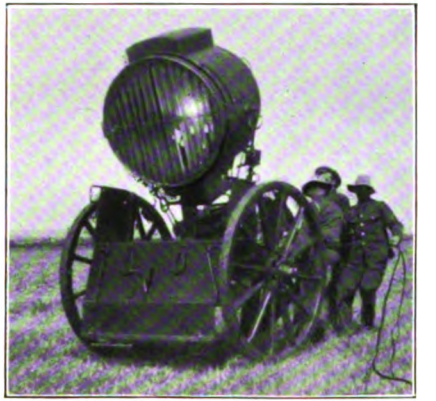
The New 4-Cylinder Siddeley Engine, and Direct Coupled Dynamo on R.G. and C.F. Carriage. Weight behind team, 48 cwt.



New Limber and Trail Carriage, carrying a 90-cm. Projector. Weight behind team, 32 cwt.



Lights used at Okehampton.



Moving the 90-cm. by hand while "running."

Digitized by Google

# *SEARCH LIGHTS IN FIELD OPERATIONS.*

*By* Capt. R. Walker.

No one will deny that Search Lights have their uses in night operations. How far they may be useful is open to discussion. It is obvious, too, that there are occasions when to use them is a mistake; and also that when once it has been decided to employ them, it is equally a mistake to expose them too soon.

It will be as well to lay down at once what lights can do, and how far they make night operations approximate to day operations in discovering the enemy and enabling aimed rifle fire to be brought upon him. This, we may assume, is their primary *rôle*.

The power of illumination on land (spoken of generally as "Ranges"), is so dependent on the nature of the terrain and atmospheric condition that the figures given below, which have been fixed for this country on an averagely clear night, may in many other instances—such as on a very clear night, or in Egypt or South Africa—be considerably increased.

## (1). In Defence.

(*a*). Dispersed beams can illuminate the foreground up to 600 yards, and within this distance bodies of advancing troops can be easily detected. Low-power glasses are necessary beyond this range.

(*b*). Concentrated beams in conjunction with expert observation can be employed to watch a defile, bridge, road, or edge of a wood at 3,000 yards distance.

## (2). In Attack.

(*a*). Concentrated beams can illuminate an objective, or indicate direction, or give any determined signal when 2 miles distant from the advancing troops.

(*b*). Concentrated beams can assist artillery fire at ranges up to 3,000 yards.

(*c*). Concentrated beams will assist an advance by lighting up the ground, especially when the defenders have no lights.

Digitized by Google

## GENERALLY.

Lights impart confidence, can seriously impede the enemy's vision, and are useful for long-distance signalling by day or by night.

Their limitations and their disadvantages are as follows :—

(1). Mist, or rain accompanied by mist, makes them useless.

(2). It is impossible to have an absolutely silent engine, although it is possible to have a light-tight projector.

(3). An insufficient number of lights (in defence) may be a source of danger by imparting false confidence.

An insufficient number of lights means that some beams must be "wandering," and when these are used, attacking troops can get close up, although it may take time; and while the defenders are looking for the attack in the beam, they may be rushed from the dark intervals.

For effective defence a fixed illuminated area in front of the position must be obtained, necessitating a very large number of lights.

(4). In close broken country, like the south of England, it is almost impossible to ensure this illuminated area without siting the lights too far in advance and endangering them.

(5). There will always be difficulties in getting the lights away, for they are most useful when the attack has come in to close ranges.

Experience to date has proved that lights must be in, or very near to, the firing line; the ideal ground where it is possible to site them 500 yards behind the firing line shining over the defenders' heads, is rarely met with.

(6). In case it is necessary to change position during the night, the move can never be done in absolute silence, with wheeled vehicles and horses.

(7). If inadvertently exposed before the proper time, a point is immediately given for the attack to march on, and for the hostile gunners to range on.

(8). To ensure the best effect, a very careful and reliable system of communication is necessary between the O.C. Lights, the O.C. Defence Section, trained observers in front, and the O.C. R.A. This is not easy to arrange for at night.

(9). If used at all, the element of surprise—which up till now has been the "leading factor" in all night operations—is done away with.

With these points before us, it is possible to determine what lights are the best, and what must be the essential details of construction.

Digitized by Google

### For Defence.

The majority of the lights should be 35-cm. (14″) size, and three of these lights can be run off one engine. Their use approximates to that of Maxim guns and they can be easily man-handled if necessary.

In addition, positions could as a rule be formed in any defensive position for one or two 90-cm. lights (3′) with wide (45°—30°) dispersed beams shining to the front, and also for one or two 10° and 16° dispersed beams shining across the front of a position.

### For Attack.

Large 90-cm. lights are of most use, concentrated beams sited over a wide arc. Small lights (35-cm.) would be very useful in the last stages of the attack, keeping directly in rear of it and above it, and shining into the eyes of the defence.

### Essential Features of Construction.

The employment of field search lights approximates to that of Maxim guns and field artillery, and in their construction this fact must be kept in view.

### Large and Medium Lights, 90-cm. and 60-cm.

The projector itself is mounted on a trail carriage fitted with springs and having seats for two men and buckets for four rifles. It should be made absolutely light-tight, *i.e.*, when running it must be invisible from the front; it must be capable of accurate and easy "setting," the traversing gear must be on ball-bearings, and used in conjunction with a graduated arc and pointer.

Rough siting arrangements are necessary. All other details, such as lamp, recording instruments, and switch, must be simple and strong and part of the projector.

The trail carriage must be fitted in front with a bullet-proof shield, and must carry a box with a spare reflector. In the trail boxes small stores, such as carbons, pliers, etc., must be carried.

The limber carries the 300 to 400 yards of twin cable and all other necessary stores. It is hung on springs, and carries two men and four rifles; it is fitted for pole draught and quick release R.A. harness. The whole weight behind the team of four horses must be kept under 30 cwt. The brake on the trail carriage is operated from the rear of the trail carriage. The small size (35-cm.) should follow on these lines. The weight must not exceed 16 cwt. It should be possible to carry a pair on each carriage.

We are at the present time ready to standardize the heavier type of trail carriage and limber. The projector has been standardized.

Digitized by Google

It has been the custom up to date to transport three small lights in one G.S. wagon, moving into position by hand; but this method is impracticable, as capture is inevitable, and must give way to the trail carriage.

We may here assume, and experience proves it, that two sizes of lights are sufficient for all requirements—the 90-cm. or 3′, and the 35-cm. or 14″.

## THE ENGINE WAGON.

The engine wagon is an ordinary 4-wheeled wagon with under-lock forecarriage, hung on stout springs, and having a strong rear brake.

The engine is a 4-cylinder 18-H.P. Siddeley, starting on petrol and running on paraffin. This, and a direct-coupled dynamo of 8 kw. are carried suspended between the main girders of the frame, the centre of gravity being kept as low as possible.

Over this is constructed an iron framework body consisting of four angle-iron corner pieces, 3′ high, carrying a sheet-iron roof. The ends are boarded, and the sides are covered by curtains or sliding doors. The underside of the engine and dynamo is also protected. The wooden end behind serves as a switchboard, and carries the stands and straps for the rifles. The weight behind the horses should not exceed 50 cwt.

## ORGANIZATION.

It is considered that 1 company with headquarters and 3 sections is sufficient for 1 division of the field army.

Each section, at war strength, consists of—

Two 90-cm. lights and four 35-cm. lights.
2 engine wagons.
1 store wagon.

The *personnel* required is—

| | | |
|---|---|---|
| Dismounted | ... | 2 sergeants, 16 rank and file. |
| Mounted | ... | 1 officer, 2 sergeants, 2 corporals, 16 drivers, 7 wagons, and 30 draught horses. |

The length of road required for the whole unit is 430 yards.

To equip 1 company would cost approximately £7,000. The upkeep during peace should not be very great, and it should be possible to organize the units on the lines of the bridging trains with a somewhat large cadre, in connection with a small school of instruction. The reason for this is that the lights will only be wanted on occasions. Their employment however differs considerably from the idea of a train, and this is the difficulty. When lights are wanted

Digitized by Google

they must be handled as smartly, and be as reliable in action as field guns are at present. For this, high training is required, especially as everything must be done in the dark and in silence.

It is not generally known that there were nearly 100 search lights of sorts in use during the latter part of the South African War, and since then they have been used in the Russo-Japanese War, the Natal Rebellion, 1906, and by the Germans in South-West Africa.

Besides the uses already quoted, and borne out by three years' experience in peace time, other instances are bound to crop up in war time when lights would really be of great assistance.

The following are suggested :—

(1). To assist in the night reconnaissance of a well-defined position.

(2). In conjunction with cavalry to dispute the passage of a ford or bridge, and to stop the construction of a hostile bridge.

(3). Long-distance signalling, up to 40 miles or more. This is rarely possible in England.

(4). Deceiving an enemy by exposing lights some miles away to a flank.

(5). To detect and oppose a night retirement after a hard-fought action.

(6). For general illumination—of a battlefield after an action, of a camping area, and in several other cases.

(7). On the lines of communication.

(8). In detached posts, blockhouses, armoured trains.

(9). On all occasions for savage warfare the presence of one light will save much tedious night outpost work, and will be likely to prevent night attacks.

## VULNERABILITY.

Ranges of an opposing light can be quickly and accurately taken with Service range-finders, and no difficulty is found in laying guns directly on a search light. Laying rifles and machine guns when in the beam of light is harder, but can also be done. For accurate shooting the sights must be illuminated.

It is however a difficult matter to "knock out" a search light. Of course, a projector, if sited in the open without frontal or head cover, would sooner or later suffer from shrapnel fire. But the difficulty of observing artillery fire, the ease with which lights can be doused and moved, the smallness of the target, and the possibilities of providing adequate cover make it very difficult to hit the projector.

If the beam is reflected from a plain glass mirror, the light is quite invulnerable, but this is only applicable to semi-permanent works.

Digitized by Google

As regards the reflectors, a glass one supported over its back will hold three or four bullet holes, and the light at close ranges is little affected until a large part of the reflector is shot away. A metallic reflector, when struck, rapidly loses its shape, and a ragged beam is the result.

Until the untarnishable metallic reflector is produced, experience teaches that it is best to use glass and take the risk. Parabola-ellipse reflectors are used instead of front door lenses (the difficulties of producing an accurate metal P.E. reflector have not yet been overcome).

The value of lights was proved in the South African War, and as stated above there were nearly 100 in use during its later stages, chiefly in armoured trains, in blockhouses, and fortified posts on lines of communications.

It has been said that two lights of the Boers considerably helped them in their advance to attack Wagon Hill. There are cases, too, when lights were bombarded, but no instance of their being destroyed.

The Russians at Port Arthur had at one time seven lights in use, and although their usefulness was belittled by the Japanese, it is a known fact that no further night attack was made after August 23rd, when they lost over 5,000 men. Their own two lights, being sited some 6,000 yards in rear, were of little help, while the Russian dispersed beams gave such valuable assistance that the Japanese attack on the parts of the defensive position, where the lights were installed, failed completely.

Bearing on this, the following extract is of considerable interest, from *The Great Siege*, by W. B. Norregard, who was formerly an artillery officer, and was present with the Japanese forces, as correspondent, when they were besieging Port Arthur :—

A strong detachment marched against the entrenchments at the foot of Itzeshan and the Shuishi lunettes. The Russian search light from Itzeshan soon detected the moving troops, and we saw that, instead of seemingly flashing erratically all over the ground, it suddenly became fixed and immovable. The Japanese advance was slow and cautious. The light blinded and confused them, and where they were exposed to its rays the Russian bullets fell fast and furious. With no means of retaliation against their enemies, hidden behind a stream of light, they had to take cover during the advance in declivities in the soil or behind mounds or hillocks, where the rays of the implacable light could not reach them. The Japanese artillery tried to destroy the light. We could see small clouds of smoke and dust springing up in front of it, and for a moment draw a thin veil across it, and from our angle of observation we saw shells burst nearer and nearer. Suddenly the light went out; a shell which burst right in front of it had been lucky enough to hit it, we thought, and the night seemed doubly dark after. Taking advantage of this darkness, the Japanese advanced rapidly. There was no longer any

Digitized by Google

need for caution; it was all-important to come to close quarters with the enemy before another light was turned on them. They had advanced to some 400 or 500 yards from the Russian positions, when suddenly the light flashed out again. And not that alone, but the light from Golden Hill and another light from somewhere behind the Erhlung forts, which we had not seen until then, concentrated on them, and in the combined glare of the three search lights the Japanese stood out against the darkness like lantern pictures on a screen. Instantly a tremendous fire opened on them from rifles and especially from machine guns, which at this range played sad havoc amongst them on the coverless plain.

The author also adds :—

It is a noteworthy fact that after August 23rd no night attack was ever made by the Japanese on any place where the rays of the light could reach them, whilst all the Russian sorties and counter-attacks have been made at night, when they could have the assistance of their lights.

Several night marches and night attacks were made by the Japanese in Manchuria, but only once was a large force employed. This was at San-kai-shih-shan, where it was successful against a stubborn defence by the Russians. The Russians had ordered 10 sets of portable horse-drawn lights for their field operations, but they did not arrive at the front in time. It would be interesting to know what influence the presence of lights would have had on this battle. Then again, when the Japanese made other attacks at night they usually found the Russians had retired. Would not these lights have imparted some confidence to, at any rate, a portion of the firing line, and helped them to "remain?"

What conclusions, then, are to be drawn? Are lights wanted with the field army or not?

Experience gained since April, 1905, in peace operations at Aldershot, Okehampton, Salisbury Plain, Chatham, and command manœuvres may help us to a decision.

They are of undoubted use in a defensive position, provided that :—

(1). There are a sufficient number of them.
(2). They are sited to illuminate a fixed area, and, as a rule, are not allowed to "wander."
(3). They can be made invisible from the front when fully turned on, but ready to be exposed at any moment when information has been received from advanced observers that the enemy is advancing to the attack.

They should be used in conjunction with efficient obstacles and to assist machine-gun fire. They should, wherever possible, be sited in rear of the firing line, to give assistance to aiming by their diffused light.

Digitized by Google

*In attack* their use is not so obvious, but given a well-defined target, they can materially assist artillery fire, and aid an advance by illuminating an objective.

*In counter-attack* it is claimed that, by their aid, it should be possible to throw back or disorganize a force which is assembling within short range of a defensive position, with a view to attacking at dawn.

Their moral support no one will deny.

Taken altogether, their assistance to night operations must not be lightly ignored, for should we find ourselves opposed to an enemy provided with search lights we should be at a disadvantage, and the extent of our night operations would be curtailed if we had not got them ourselves.

Other armies, we know, have field search lights, and, if only to put us on an equal footing, we should adopt them, and should we ever be opposed to an enemy not provided with lights, we shall then hold a distinct advantage.

Digitized by Google

# *NOTES ON REINFORCED CONCRETE* VERSUS *WOOD.*

*By* MAJOR A. H. D. RIACH, R.E.

THE use of reinforced concrete in lieu of steel, brick, and stone is rapidly becoming more general, but its advantage as a substitute for timber is, at first sight, less evident. As a general rule good timber can be subjected safely to greater stresses, both in compression and tension, than armoured concrete, and the consequent greater dimensions required for members of this material, its great weight and the care needed in its manufacture, would appear to outweigh any arguments in favour of its adoption for beams, rafters, small posts, etc., in ordinary building construction, particularly when the adaptability of wood, and ease with which it can be worked, is taken into account.

In the new barracks at Jubbulpore, Major Stokes-Roberts, R.E., has however taken the bold departure of making up (amongst other parts of the buildings) door frames, verandah rafters, battens, bressummers, pillars and pillar caps of concrete suitably reinforced, and finds that he has effected a large saving thereby.

The following notes, describing the methods and first results of a trial of the same material, now in progress in the barracks at Ahmednagar, may be of interest.

In the barracks first built the lintels were made of reinforced concrete, and the pillar bases and bedstones for trusses of plain moulded concrete blocks. Except for small areas of flat roofs, no other armoured concrete was introduced. The verandahs are roofed with tiles on wooden rafters, posts, etc. It is proposed to discuss in this article however the advantages of employing reinforced concrete in members usually made of wood.

*Nature of Members Manufactured.*—It was considered that no gain would result from the use of concrete rafters and battens on account of the largely increased dimensions necessary for these members. On the other hand, the posts, pillar caps, bressummers, and verandah wall plates needed little or no increase of dimensions, and these have therefore been made up, as described and illustrated below. The standard spacing of verandah pillars was fixed at 9′ c. to c. (in lieu of 7′ 6″, as hitherto adopted for timber), rafters being 3′ c. to c.

*Materials Available.*—An abundant supply of shingle of all sizes, from ¾″ downwards, is available, and this forms an ideal aggregate, after washing and screening out all pieces below ¼″. The sand available is poor, being round, friable, and hard to clean thoroughly,

Digitized by Google

but in practice excellent results have nevertheless been obtained. The proportion of voids in the shingle ballast is low, and the quantity of mortar needed for a dense concrete is consequently less than the average. It has therefore been possible to reduce the proportion of sand to cement to below what is usually given, without increasing the cost of the concrete.

*Proportions for Concrete.*—A concrete of 3 parts shingle, ½ part sand, and 1 part cement (by volume) has been used for pieces likely to be subjected to direct blows, *e.g.*, for posts for wire railings, or for chairs of verandah posts in barracks, and has proved exceedingly tough. For lintels and members not liable to direct shocks the proportion of 5 shingle, 1½ sand, and 1 cement has proved satisfactory. With shingle up to 1″ gauge, 5 shingle, 2 sand, and 1 cement is used. For the work herein described the proportion adopted is 4 shingle, 1 sand, and 1 cement.

*Consolidation.*—The proportion of mortar being low, greater care in consolidating is taken than is customary in American and Continental practice. Every mould is well tamped as it is being filled, and when filled the surface is thoroughly rammed with the heaviest rammers of which the surface will admit. The result is a very compact concrete.

*Proportion of Water.*—Much depends on the right proportion of water being given. For clean surfaces and compactness the concrete is mixed so that while it looks only damp when being handled, yet, on ramming, water comes readily to the surface, and the whole becomes quaky. If the unrammed concrete is wet and pappy-looking, it is not possible to effectively consolidate it in small moulds owing to the excessive sloppiness. In heavy masses (*e.g.*, bridges) more water is beneficial, as less ramming can be given than with small batches; in short, the more the ramming, the less the water.

Actually in practice proportions work out to :—

(*a*). For lintels, in moulds which can be rammed with heavy rammers, 12 gallons of water to 10 c.f. of completed product. This works out to shingle 5 c.f., sand 2 c.f., cement 1 c.f., water ·95 c.f.

(*b*). For the posts, bressummers, etc., described in this article, 13 gallons of water to 10 c.f. of finished articles, *i.e.*, 4 c.f. shingle, 1 c.f. sand, 1 c.f. cement, ·83 c.f. water (the amount of shingle used is almost exactly the cubic measure of the finished article, except with very rich mixtures).

*Weight.*—The average weight of the finished articles is 153 lbs. per cubic foot. The weight of the ingredients is :—

| | | | | | |
|---|---|---|---|---|---|
| Shingle, unrammed, dry | ... | ... | ... | 92 lbs. | per c.f. |
| Sand, loose, dry | ... | ... | ... | 95 lbs. | „ |
| Cement, loose... | ... | ... | ... | 92 lbs. | „ |

Digitized by Google

*Specific Gravity and Porosity.*—The specific gravity of the concrete alone, varies from 2·44 to 2·62 (the higher figure being for a block of concrete of 1 cement, 1 sand, and 3 of hard black trap ballast). The porosity (*i.e.*, ratio of increase of weight after thorough wetting) from 1·6 to 3·6 per cent. This factor is relative, and not absolute, as the degree of dryness is a variable quantity, for in wet weather the increase of weight due to soakage of water will be less than in dry weather. It is given as affording some indication of the compactness or density and watertightness of the concrete. The porosity of samples of 1:2:4 cement concrete obtained elsewhere, and tested at the same time, varied from 5·2 to 8 per cent.

*Armouring.*—It is very convenient to make up the armouring as a skeleton, ready to drop into the moulds. The skeleton armour is shaken as the concrete is being filled into the moulds, to get the rods into correct position and well-embedded. No rods have been found exposed when moulds are removed.

*Moulds.*—It has been found profitable in every way to manufacture the pieces in moulds with a large number of partitions (*vide Plate* I., illustrating the moulds used for railing posts, and *Plate* II., those for bressummers). In every member, the armouring of which is unsymmetrical, the lower edges are chamfered, or the tops and bottoms of the pieces otherwise distinguished. The moulds are made of wood, carefully planed and sandpapered, and pickled in cocoanut oil for three days. The base plates consist of steel plates. Great care is taken with the fitting of the moulds, as it has been found that roughened and warped moulds give much trouble.

*Oiling.*—Before filling, the whole is wiped over with a fairly dry oil rag, and no concrete ever sticks. The armouring is then placed in position (care being taken that no surplus oil is about, to get on to the armouring), and the bolts to form holes for dowels, etc., are wiped over with the oil rag and fixed.

*Treatment after Consolidation.*—These bolts are turned as soon as the mass has been rammed, and are removed the following morning. The sides of the moulds can be removed after 24 hours, but otherwise the pieces are left untouched for 10 days under straw, which is kept well wetted. They are then removed and stacked, and kept wet for a further five days or more. It is most desirable to allow them to dry out in the shade. Sudden partial drying in the sun is liable to cause unequal shrinkage and hair cracks, which are unsightly and may cause weakness. This applies especially to slabs and thin pieces, and particularly in dry weather. Ten days on their beds is laid down ; if handling earlier is unavoidable, it must be done with the greatest care.

*Touching Up and Surfacing.*—Surfacing, if required, is done on the tenth day (exposed surfaces can be surfaced on the second day). The pieces come out with clean surfaces and sharp arrises, and, except for the sake of appearance, they need no touching up other than filling

Digitized by Google

in a few holes left by excess water, or touching up chance injuries; in fact, the surfaces are so clean that they have to be roughed before sand rubbing will adhere.

*Sand Rubbing.*—The sand rubbing is done by applying and rubbing in with wooden floats the thinnest possible skin of specially chosen sand 2 parts and cement 1 part. Care is taken to avoid streakiness in this coating. Trowels are unsuitable as they give a polished surface. The difficulty of making the sand coat adhere is a defect to be guarded against.

*Ornamentation.*—The simplest possible design is followed, viz., plane surfaces with plain chamfers, the members being treated as cut-stone. It is considered that in barracks, otherwise plain and solid, the addition of anything in the nature of florid embellishments would be out of place. At the same time ornament can be applied with little extra trouble if desired.

*Conditions of Work and Labour Employed.*—The work is done as far as possible under cover. Two trained masons with a few coolies are constantly employed; they fill three or four moulds daily, empty a corresponding number which have lain 10 days, and surface and water as required, in rotation. The armouring is made up into skeletons beforehand by one or two khalassies. A carpenter is employed, if specially required, for alterations or repairs to moulds. In this way no labour is wasted, and supervision is reduced to a minimum, a most important matter when the quality and trustworthiness of the product depends on reliable work efficiently supervised.

*Cost.*—The following details show the cost of the work; they are actual figures, not specially selected :—

I. 112 RAILING POSTS* OF 1 CEMENT, ½ SAND, 3 SHINGLE, EACH $6' \times 4'' \times 4'' = \frac{2}{3}$ C.F.—TOTAL, 75 C.F.

| | R. | a. | p. |
|---|---|---|---|
| 72 c.f. screened and washed shingle at R.3 8a. per 100 c.f. ... ... ... ... ... | 2 | 8 | 3 |
| 24 c.f. cement at R.2 per c.f. ... ... ... | 48 | 0 | 0 |
| 12 c.f. sand, washed, at R.3 per 100 c.f.... ... | 0 | 5 | 9 |
| 3 cwt. ¼′ round steel, mild, at R.8 per cwt. ... | 24 | 0 | 0 |
| 1 cwt. wire, 150 lbs. to the mile, at R.14 per cwt. | 14 | 0 | 0 |
| Labour ... ... ... ... ... ... | 28 | 0 | 0 |
| Straw, oil, etc. ... ... ... ... ... | 1 | 2 | 0 |
| Total ... ... | R.118 | 0 | 0 |

Cost per c.f., R.1 9a. 2p., exclusive of surfacing.

These are for use in lieu of jarrah wood posts of the same dimensions, costing R.2 per c.f., unwrought. There is a gain of say 8a. per finished post in favour of concrete. The resulting railing is neat and satisfactory.

* As *Plate* I.

Digitized by Google

## II. Ferro-Concrete Work in Pillars, Bressummers, Caps, Gate Posts, etc., of 1 Cement, 1 Sand, and 4 Shingle.

*Work Done from* 21. 1. 08 *to* 5. 2. 08.

| | | |
|---|---|---|
| 36 verandah pillars, | 6′ 2″ × 5″ × 5″ ... ... ... | =38 c.f. |
| 20 bressummers, | 9′ 0″ × 5″ × 5″ ... ... ... | =31 „ |
| 36 caps | 3′ 0″ × 5″ × 5″ ... ... ... | =19 „ |
| 6 gate posts | 6′ 0″ × 5″ × 5″ ... ... ... | = 6 „ |
| 3 struts to do. | 6′ 0″ × 4″ × 3″ ... ... ... | = 2 „ |
| | | 96 c.f. |

*Labour Employed.*

| | R. | a. | p. |
|---|---|---|---|
| 2 masons, 16 days at 14a. ... ... ... | =28 | 0 | 0 |
| 4 coolies, 16 days at 4a. ... ... ... | =16 | 0 | 0 |
| 2 women do., 16 days at 2a. 6p. ... ... | = 5 | 0 | 0 |
| 1 khalasee, 16 days at 8a. (wiring steel work) | = 8 | 0 | 0 |
| ¼ carpenter, 16 days at R.1 ... ... ... | = 4 | 0 | 0 |
| ½ bhisti, 16 days at 10a. ... ... ... | = 5 | 0 | 0 |
| | 66 | 0 | 0 |

Deduct :—

| | | | |
|---|---|---|---|
| Labour value of 24 pillar bases and 24 bed-stones made by above labour=48 at 3a. | = 9 | 0 | 0 |
| Total labour ... ... | R.57 | 0 | 0 |

*Materials.*

| | R. | a. | p. |
|---|---|---|---|
| 96 c.f. shingle at R.3 8a. per 100 c.f. ... ... | = 3 | 5 | 9 |
| 24 c.f. sand at R.3 per 100 c.f. ... ... | = 0 | 11 | 6 |
| 24 c.f. cement at R.2 per c.f. ... ... ... | =48 | 0 | 0 |
| Round steel, mild, 6 cwt. 3 qrs. 23 lbs., at R.8 per cwt. ... ... ... ... ... | =55 | 10 | 3 |
| Steel wire, 2 qrs., at R.12 per cwt. ... ... | = 6 | 0 | 0 |
| Cocoanut oil, 3 lbs., at 4a. per lb. ... ... | = 0 | 12 | 0 |
| Grass, etc., say ... ... ... ... ... | = 0 | 8 | 6 |
| Total material ... ... ... | R.115 | 0 | 0 |
| Total labour and material ... | R.172 | 0 | 0 |

Rate per c.f.=$\frac{172}{96}$=R.1 12a. 8p. per c.f.

P.S.—The above includes labour and material used in sand rubbing the surfaces.

*Issue Rate.*—The labour charges tend to get lower as the workmen become more expert. The issue rate of the members described, *including moulds*, has been fixed at R.2 per c.f.

Digitized by Google

Including the comparatively simple lintels, with their lesser proportion of cement and the pillar bases which have no armour, an all-round rate of R.2 per c.f., *fixed in position*, amply covers the cost of the work. In the comparative statement below this rate has been taken.

*Comparison with Cost of Teak.*—Comparative cost of teak and ferro-concrete for a verandah 100′ long.

(*a*). Mangalore tiles on battens 1″ × 1½″, rafters 3″ × 5″, bressummers 5″ × 4″, pillar caps 2′ × 5″ × 4″, posts 5″ × 5″ at 7½ c. to c., pillar chairs of concrete blocks, wall plate 3″ × 4″, all woodwork teak.

(*b*). Mangalore tiles on battens 1″ × 1½″ and rafters 3″ × 5″ of teak, bressummers, ferro-concrete, 5″ × 5″, pillar caps, ferro-concrete, 3′ × 5″ × 5″, posts, ferro-concrete, 5″ × 5″ at 9′ c. to c., pillar chairs of concrete blocks, wall plate, ferro-concrete, 3″ × 4″.

Detail of cost of above :—

(*a*).

| | | |
|---|---|---|
| 14 concrete chairs 1′ × 1′ × ⅔′ | ...= 9·33 c.f. at R.2 c.f. | =R. 18·66 |
| 14 posts, teak, 6′ 6″ × 5″ × 5″ | ...=15·80 | |
| 14 pillar caps, teak, 2′ × 5″ × 5″ | ...= 3·89 | |
| 100′ bressummer, teak, 5″ × 4″ | ...=13·89 | |
| 100′ wall plate, teak, 3″ × 4″ ... | ...= 8·33 | |
| | 41·91 at R.3 12a. c.f. | =R.157·16 |
| 14 holding-down bolts, complete, at 6¾ lbs. | ... =94½ lbs. | |
| 14 straps for posts, complete, at 4½ lbs. ... | ... =63 „ | |
| 34 rafter cramps, complete, at 2 lbs. | =68 „ | |
| 34 connection rafter to wall plate at ⅓ lb. ... | =33⅓ „ | |
| | 258⅓ lbs. at R.21 cwt. | =R. 48·56 |
| | Total ... | R.224·38 |

Digitized by Google

(*b*). 12 concrete chairs
1′ × 1′ × ⅔′ ...= 8 c.f.
12 posts, ferro-concrete, 6′ 2″ × 5″ × 5″ ... ...=12·85
12 pillar caps, ferro-concrete, 3′ × 5″ × 5″ ... ...= 6·25
100′ bressummer, ferro-concrete, 5″ × 5″ ... ...=17·36
100′ wall plate, ferro-concrete, 3″ × 4″ ... ...= 8·33

52·79 at R.2 =R.105·58

12 anchor dowels for chairs, complete, at 4½ lbs.... =52 lbs.
12 dowels for posts ½″ × 9″ at ½ lb. ... = 6 „
3 × 12 dowels pillar caps ½″ × 9″ at ½ lb. ... ... =18 „
22 dowel bolts for rafters with nuts ½″ × 10″ at ⅔ lb.... =15 „
12 ditto with turned ends at ⅘ lb. ... =10 „
34 connections wall plate and rafter at ⅔ lb. ... ... =29 „

130 lbs. at R.21 cwt.=R. 24·38

Total ... R.129·96

Saving ... R.94·42

*Practical and Financial Advantages.*—These figures show a saving, bulk for bulk, in favour of ferro-concrete of R.1 12a. per c.f., or, in the case of the verandah, a saving of 15a. per r.f. of verandah, due to this and the increased spacing of the posts permissible with concrete bressummers. Adding the cost of painting, initial and recurring, the saving comes to R.1 per r.f. of verandah.

Digitized by Google

It is therefore evident that when it is found possible to run the manufacture of reinforced concrete under proper supervision, and with a sufficient output to pay for the moulds and other initial expenses, a very substantial gain can be realized by employing this material extensively in place of teak or other expensive timber. Once erected, the members need no maintenance and are practically indestructible.

*Strength.*—Finally as regards strength.

The formula employed is as follows :—

Factor of safety, 3.

$d$=effective depth (*i.e.*, to centre of reinforcement) in inches.

$b$=breadth in inches.

Mild steel bars.

For supported beams uniformly loaded

$$bd^2=\frac{WL}{X}$$

where W=safe distributed load in pounds.

L=span in feet.

X=45, 57, 73, 100, and 130 where percentage of armour is $\frac{1}{2}$, $\frac{3}{4}$, 1, $1\frac{1}{2}$, or 2 per cent. respectively.

(Major Stokes-Roberts' *Application of Reinforced Concrete*).

The following tests of members, made as specified hereafter, serve to show that the factor of safety allowed by this formula for members loaded as beams is sufficient even when the members have a visible defect. They also confirm results already observed, that the adhesion of the armouring to the concrete is not sufficient to prevent round rods from drawing, when subjected to a tensile strain far short of that which can be borne when the armouring is prevented by its shape from drawing.

Carefully-made members, with armouring suitably applied, can be safely stressed to a far higher limit than that given by the formula.

I. *Test of Railing Post.*—Ferro-concrete railing post, made as per *Fig.* 6, *Plate* I., age $3\frac{1}{2}$ months.

Post tested had been cracked through at the centre, crack visible on all four sides, and had other cracks, due to carelessness during manufacture.

In order to see what it would stand in its defective state, it was tested as follows :—Beam supported, clear span 4′ 6″, load suspended by slings from centre. Load oscillated considerably, and is assumed to be equivalent to a dead *distributed* load $2\frac{1}{2}$ times greater.

Load 634 lbs. applied, and again removed.

Beam recovered ·12″.

Digitized by Google

Load 761 lbs., deflection ·18″, some flaking at top edges of central crack, bottom edges opened slightly.

Load 886 lbs., deflection ·36″.

Load 1,013 lbs., beam broke slowly by crushing at upper edges of central crack and drawing of lower rods of armouring, *which were not fishtailed or bent* to prevent drawing.

Beam did not fall.

Effective section of beam = $4'' \times 3\frac{1}{4}'' = 13$ square inches.

Section of armour in tensile edge = $2 \times \cdot 049 = \cdot 1$ square inch say.

$\therefore$ proportion of armour = $\frac{\cdot 1}{13} = \cdot 77$ per cent.

From formula $ba^2 = \frac{WL}{X}$, where $X = 57$,

$$W = 4 \times \frac{169}{16} \times \frac{57 \times 2}{9} = 535 \text{ lbs.}$$

= safe distributed dead load.

By assumption, the breaking load of 1,013 lbs. = $2\frac{1}{2} \times 1{,}013 = 2{,}532$ lbs. distributed dead load.

The factor of safety is therefore nearly 5, with seriously defective beam ; strength would have been greater had rods not drawn.

II. *Test of Bressummers.*—Tests of 5″ × 5″ ferro-concrete bressummer (Specification III.) moulded between 20. 2. 08 and 5. 3. 08. Tested 5. 5. 08.

Load applied symmetrically and distributed over bressummer and 4″ × 5″ teak joist, both supported over 6′ clear span.

Load 2,800 lbs. = 1,400 distributed over each beam, no observable result.

Load increased to 3,422 lbs. on each beam.

Bressummer deflected about $\frac{1}{16}''$.

Load left on for eight days, deflection increased to nearly ·2″.

Load lifted by jacks, beam regained ·177″.

Load reapplied, deflection of f.c. beam ·35″, of teak beam, ·48″.

Load 6,000 lbs. per beam, deflection of f.c. beam ·52″, of teak beam ·62″.

Load 7,900 lbs. per beam, deflection of f.c. beam ·53″, of teak beam ·70″.

Load lifted, residual deflection, f.c. beam ·06″, of teak beam ·02″.

F.c. bressummer had a central crack visible before testing. This did not develop, and beam was absolutely serviceable after test.

As load was applied in a manner which *may* have caused formation of a bridge effect, a further test was made, as below.

III. Similar ferro-concrete bressummer, and teak joist 4″ × 5″, clear span 6′, beams supported, load applied symmetrically to both beams and distributed. Tested 21. 5. 08.

The deflection of f.c. beam is shown in the following diagram (*Fig.* 1).

Digitized by Google

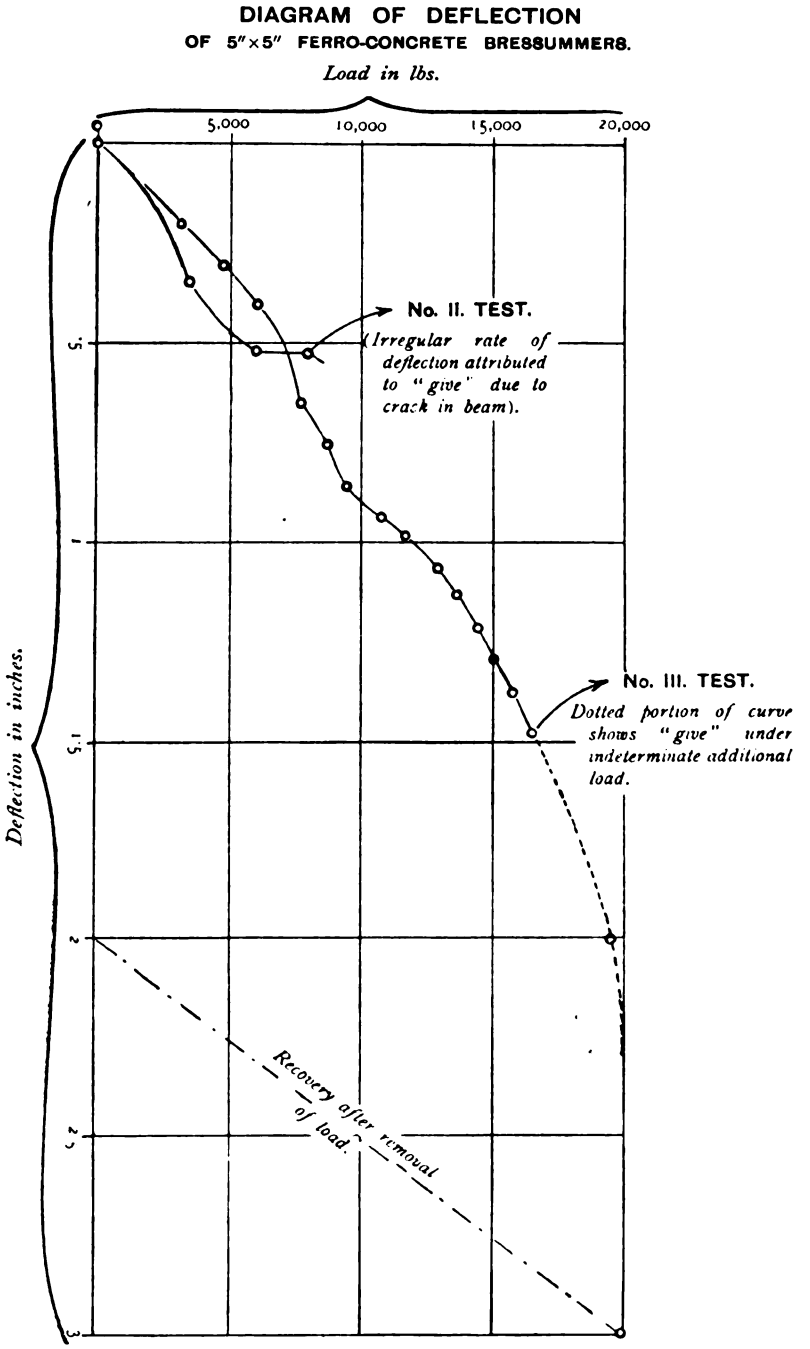



FIG. 1.

Digitized by Google

| Load on each Beam in lbs. | | Deflection. | |
|---|---|---|---|
| | | F.C. Beam. | Teak Beam. |
| 1,550 | Left on all night, deflection gradually increased to ..... | ·15 | ·12 |
| 6,125 | Do. do. | ·40 | ·56 |
| — | Load jacked off, no residual deflection ..... | — | — |
| 6,125 | Again re-loaded, deflection as before ..... | ·40 | ·56 |
| 8,770 | Do. do. | ·75 | 1·08 |

Deflection of f.c. beam increased gradually as load was added to up to 2″, and, after load had remained on for 24 hours, to nearly 3″. That of teak beam increased at a lesser rate, but accurate progressive record was not kept.

After uniform load had been increased to 16,364 lbs. per beam, deflection of f.c. beam was 1·47″ and of teak beam approximately 2″. Further load then applied unsymmetrically, in such a way as to reduce load on teak beam, deflection of which was $1\frac{1}{3}$″ after 24 hours.

Total load applied to f.c. bressummer amounted to not less than 20,000 lbs.

As no further load could be applied without endangering the coolies employed and neither beam had broken, load was removed after four days.

The condition of the ferro-concrete beam, when still under the load, on 22. 5. 08 is shown in *Fig.* 2. Both this and the teak beam may be said to have been stressed almost to fracture.

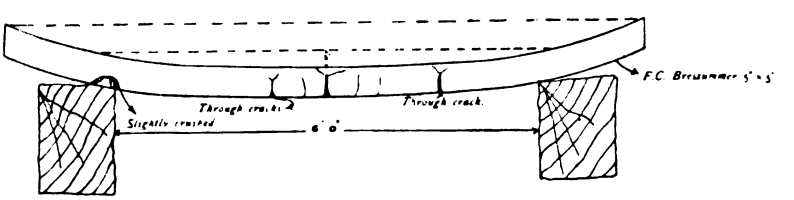



FIG. 2.—*Beam under Maximum Load* (200,000 *lbs.*). *Showing Deflection after* 24 *hours.—East Side.*

*Scale—*$2\frac{1}{2}$ *feet* = 1 *inch.*

Digitized by Google

On removal of load the concrete beam recovered 1″ (*vide Fig.* 3), and the teak beam almost entirely. The latter is usable, but shows a horizontal crack $1\frac{1}{2}$″ above and parallel to the lower edge of the beam.

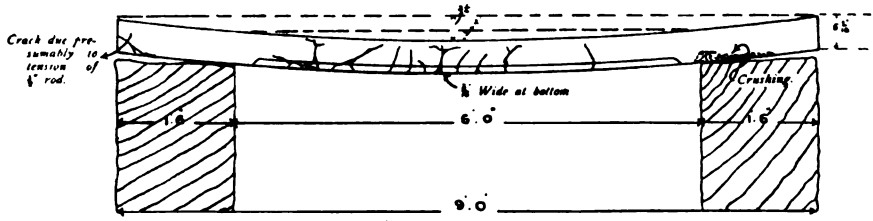



FIG. 3.—*Beam Five Weeks after Removal of Load.—West Side.*
*Scale—*$2\frac{1}{2}$ *feet* = 1 *inch.*

In the concrete beam crushing is apparent at one of the points of support, and also at one end, where the splayed $\frac{1}{2}$″ rods of the armour had apparently commenced to tear through the concrete.

IV. *Test of Wall Plate.*—Test of 3″ × 4″ verandah wall plate (Specification IV.), moulded on 13. 7. 08, tested 19. 11. 08.

Load applied symmetrically and distributed over ferro-concrete beam and teak beam of same dimensions (3″ × 4″), both supported over 5′ clear span :—

| Distributed Load on each Beam in lbs. | | Deflection in Inches. | |
|---|---|---|---|
| | | F.C. Beam. | Teak Beam. |
| 144 | ..... | ·05 | ·085 |
| 596 | ..... | ·085 | — |
| 1,008 | ..... | ·15 | ·245 |
| 1,296 | ..... | ·265 | ·35 |
| 2,016 | ..... | ·425 | ·51 |
| — | Load lifted, residual deflection ... | ·085 | not measured |
| 2,016 | Deflection as before..... | ·425 | — |
| 3,024 | ..... | ·585 | ·69 |
| 3,456 | Teak beam suddenly failed..... | about ·65 | fracture |

Failure of teak beam, throwing all the load into the ferro-concrete beam, caused the concrete to crush and beam to fail at the centre.

Digitized by Google

Steel armour bent, but load did not fall to the ground. Horizontal shearing cracks formed at each end and near quarter spans during failure. Rods did not draw.

V. *Test of Batten.*—Test of 2″ × 1½″ ferro-concrete batten armoured with four rods $\frac{3}{16}$″ diameter. Age of test pieces about two months, tested 19. 11. 08.

Load applied symmetrically and distributed over batten 2″ × 1½″ on flat, and similar batten on edge, both supported over 5′ clear span :—

| Distributed Load on each Test Piece in lbs. | | Deflection in Inches. | |
|---|---|---|---|
| | | Batten Flat, 2″ × 1½″. | Batten on Edge, 1½″ × 2″. |
| 150 | ..... | ·61 | ·31 |
| — | Load lifted. Deflection at once decreased to ..... | ·125 | — |
| 150 | Load re-applied, deflection as before | ·61 | — |
| 250 | ..... | failed slowly | — |

The failure was due to the gradual crushing of the concrete at the centre of the upper edge and the bending of the steel rods. No shearing cracks or drawing of rods apparent. Failure occurred at central hole in member. After the test the 1½″ × 2″ piece carried two men, say 220 lbs. live load, centrally, without damage. The whippiness of these small sections is most noticeable.

*Inferences.*—These tests are described in detail, as they illustrate the remarkable resiliency of the material, as well as the fact, so often remarked on, that with low percentages of armouring ultimate failure rarely occurs without unmistakable signs becoming apparent for some time beforehand.

Another point observed from these and other tests is that, for beams of approximately equal strength, concrete is considerably stiffer than teak.

Examining the results by the formulæ given in the report of the Joint Committee on Reinforced Concrete, published by the Royal Institute of British Architects, we can ascertain the maximum stresses on the materials under the loads applied, *e.g.*, test No. IV.

Effective section = $b \times d$ = 3″ × 3·25″.

Sectional area of steel = 4 × ·049 = ·196 square inch = $A_t$

(all four rods in tension at centre of beam, no armour in compression edge at this point in beam tested).

Digitized by Google

Then percentage of armour P

$$= \frac{\cdot 196}{3 \times 3 \cdot 25} = \cdot 0182$$

and $$pm = \cdot 3015, \text{ where } m = \frac{Es}{Ec} = 15$$

$$k = \frac{\text{depth of neutral axis from top edge}}{d}$$

$$= \sqrt{p^2m^2 + 2pm} - pm$$

$$= \cdot 53$$

or $$kd = 1 \cdot 722'' \text{ and } z = \cdot 574''$$

$$M = \frac{WL}{8} = \frac{3456 \times 5 \times 12}{8} \text{ at moment of failure.}$$

$$t = \text{tension on steel} = \frac{M}{A_t(d-z)} = 49345 \text{ lbs. per sq. in.,}$$

which is within ultimate strength of steel

(factor of safety as regards steel = 3).

$$c = \text{compression concrete} = \frac{2M}{A_c(d-z)}$$

(where $A_c$ = area in compression = $kd \times b$)

$$c = 3744 \text{ lbs. per square inch,}$$

giving a factor of safety for concrete of 6·2.

Similarly for Test V we find, at moment of failure,

$$t = 42300 \text{ lbs. per square inch, and}$$

$$c = 3980 \text{ lbs. per square inch.}$$

In the case of Test IV. the results would have been considerably higher had the failure of the teak beam not caused the premature collapse of the concrete member, while in Test V. the concrete had not dried out, and had not developed its ultimate strength.

Calculating from the data given in Test III. in the same manner with a load of 20,000 lbs. distributed, and neglecting the effect of the 1″ teak batten over the 5″ × 5″ beam, $t$ works out to 131,000 lbs. per square inch, and $c$ to 9,000 lbs. per square inch; but as these figures are clearly too high, the depth of the beam may be taken, for purposes of the calculation, as 5·25″. Even then we get $t$ = 104,000 lbs. per square inch and $c$ = 6,479 lbs. per square inch (assuming the ½″ rods alone to be in tension).

Digitized by Google

These figures are still very high, but the explanation may lie in the fact that the stretching of the $\frac{1}{2}''$ lower armouring enabled the tensile strength of the upper $\frac{3}{8}''$ rods to come into play. The results by any computation show the ultimate strength to be far in excess of the commonly accepted limit.

*Reduced Scantlings Permissible.*—From the foregoing it appears that the sizes of the members as made up are needlessly great, and that the saving shown as attainable can be further increased, particularly in buildings where the liability to improper usage is less than it is in barracks.

*Watertightness and Corrosion.*—One matter more calls for remark, namely, the possibility of corrosion of the armouring in exposed situations. The $\frac{1}{2}''$ or so of concrete over the steel is sufficient to protect it under all ordinary circumstances, and it is considered that the life of the members in wet situations is at least as great as that of teak wood. For piles in wet ground, and other cases where excessive and constant moisture has to be expected, the armouring will need to be covered with a thicker layer of concrete, which must itself be rich enough to be waterproof.

Coke breeze concrete must not be used, as the sulphur corrodes the steel, and failures from this cause are on record.

*Conclusion.*—As already stated, work of this nature should not be undertaken unless it can be effectively looked after. Also it must be remembered that every piece has to fit correctly into the place it is required to occupy, so moulds, etc., must be standardized. The material can be cut with care, but all cutting and dressing should be avoided as far as possible, as it takes much time, and the concrete may be damaged. Further, it is necessary to handle the pieces with somewhat greater care than is usual in fixing carpenter's work, for it is not easy to neatly repair chipped corners, and cracks, even if they do not materially reduce the ultimate strength, are unsightly.

The excellent results here described are due to the care and interest taken by Lieut. Lee, M.W.S., by whom the workmen were instructed and supervised in every point.

The decision to extend the application of the material to buildings still to be put in hand finds ample justification in the confidence and experience already gained.

*Postscript.*—The percentage of armour it is desirable to employ is not discussed in these notes. In the specifications quoted the proportion applied at the tensile edge varies from $1\frac{1}{2}$ per cent. to 2 per cent. of the *effective* section of the member. When there is no objection to members being of larger dimensions than are needed for these proportions, it may be advantageous to reduce the armouring. The tougher the concrete the greater the percentage of the armour which

Digitized by Google

has to be applied at points subject to tension (and shearing), to balance the resistance to crushing the concrete is capable of exerting. No rule can be laid down, but in general the members should be so reinforced that when stressed to failure, that failure should be due to the gradual stretching of the steel, and not to the sudden collapse of concrete crushing (or of armour slipping).

In view of the results described in these notes, the following modifications are being introduced :—

(*a*). Verandah posts to be $4\frac{1}{2}'' \times 4\frac{1}{2}''$, armoured with four rods $\frac{1}{4}''$ diameter, tied into skeletons, as in specifications.
(*b*). Bressummers to be $4\frac{1}{2}'' \times 5''$ in lieu of $5'' \times 5''$.
(*c*). Pillar caps to be $4\frac{1}{2}'' \times 4\frac{1}{2}''$.

---

## CALCULATIONS AND SPECIFICATIONS.

I. *Verandah Posts.*—$5'' \times 5'' \times 6'\ 2''$, assumed to suit $5''$ bressummer. A plain square column with stop chamfers ($1\frac{1}{2}''$ face of chamfer) (see *Figs.* 8 to 11, *Plate* III.).

Armour, four rods mild steel longitudinally, $\frac{3}{8}''$ diameter, formed into a skeleton with wire hoops at $6''$ intervals.

Sectional area of armouring, $4 \times \cdot 11 = \cdot 44$ square inch.

Proportion of armour to total section $= 1 \cdot 76$ per cent.

Method of armouring is as adopted by Capt. Traill, R.E., at Cauvery Power Station.

The longitudinal armour is to prevent bending. The wire ties are not large enough to enable the member to resist the tendency to burst if the stress exceeds that which good concrete will safely stand. This is taken as 350 lbs. per square inch for the type of construction employed (hooped concrete columns may be safely stressed to nearly three times this limit).

(Calculating as per *Military Works Handbook*, Formula V., where

$$l = 15h \text{ and } c = 350 \text{ lbs. per square inch.}$$

$$P = \tfrac{1}{2} cs = \frac{350 \times 25}{2} = 4{,}375 \text{ lbs.}$$

Now with posts $9'$ c. to c., roof slope $12'$, of which $\frac{2}{3}$ is borne on bressummer, $W = 9 \times \frac{12 \times 2}{3} \times 30$ lbs. $= 2{,}160$ lbs. So column is twice as strong as is necessary for safety for $10'$ wide verandahs).*

* Rafters are secured to wall plate, which is itself secured to wall, so roof does not tend to slide downwards.

Digitized by Google

At each end of the post a hole, $\frac{5}{8}''$ diameter and $4\frac{1}{2}''$ deep, is moulded, to receive dowels to connect post and pillar base and post and pillar cap.

II. *Pillar Caps.*—The pillar cap consists of a plain square member, with moulded ends (see *Figs.* 12 to 19, *Plate* III.). The armouring consists of $\frac{1}{4}''$ diameter rods tied into a skeleton with wire.

Three holes, $\frac{5}{8}''$ diameter, are moulded, as shown, to receive the dowels connecting the pillar cap to the pillar and bressummers. For special cases similar pillar caps, 2′ long, are made up (*e.g.*, for use on posts next to corners of buildings).

For corner pillars, four-way pillar caps are moulded. The pillar caps are intended to act as cantilevers, so as to shorten the clear span of the bressummers.

In erection the members are bedded on a thin layer of cement mortar to ensure even bearings.

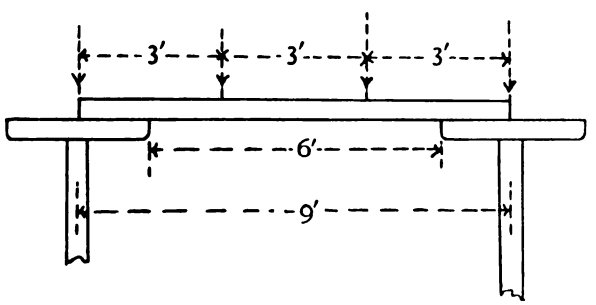
The dowels, shown in the drawings as $\frac{1}{2}''$ diameter and jagged as lewis bolts, are more conveniently made of $\frac{3}{8}''$ steel rods, slightly bent to act as a spring, so as not to fall out of holes. These bolts are bedded in cement, flushed into the holes.

III. *Bressummers.*—(See *Figs.* 21 to 24, *Plate* III.).

Take standard spacing of verandah pillars as 9′ c. to. c.

Pillar caps 3′ long.

Clear span of bressummers 6′.




Actual load is supplied at two points, each $1\frac{1}{2}'$ from support.

Scott-Moncrieff, *Principles of Structural Design*, Vol. I., pp. 72 and 73 (case 8) :—

$$M_f = W'a = W' \frac{I}{4},$$

and as $W' = \frac{1}{2}$ total load (W),

$$\therefore M_f = \frac{Wl}{8} = \text{moment of flexure for uniformly loaded supported beam.}$$

Now $$bd^2 = \frac{WL}{X},$$

Digitized by Google

and assuming percentage of armour as $1\frac{1}{2}$ per cent.,

$$X=100\text{; taking } b=5'',\ d=4\tfrac{1}{4}'',\ L=6',$$

and substituting

$$W=5\times\frac{17}{4}\times\frac{17}{4}\times\frac{100}{6}=\frac{144500}{96}=1500 \text{ lbs. say.}$$

Actually in verandah with a 12′ slope ($\frac{2}{3}$ weight borne on bressummers)

$$W=6\times 8\times 30=1440 \text{ lbs.}$$

Make bressummer $5''\times 5''$ (effective section $5''\times 4\frac{1}{4}''=21$ square inches).

Armour in tension flange, two $\frac{1}{2}''$ rods $=\cdot 39$ square inch.

„ „ top flange, two $\frac{3}{8}''$ rods $=\cdot 22$ „ „

As the beam is practically "fixed," the top armour is necessary.

For ease of manufacture the armour is made up into skeleton as for pillars.

Mould with two stop chamfers in lower flange (similar to posts).

Connections consist of $\frac{3}{8}''$ or $\frac{1}{2}''$ dowels, for which $\frac{5}{8}''$ holes are moulded as shown (see also *Fig.* 32 for arrangement of connections). All dowels bedded in cement in holes.

The armouring, if arranged as for verandah wall plates, could be reduced, but the skeleton as used is easy to fix, and the upper rods serve to prevent development of cracks prior to fixing, and is recommended for these heavy members.

IV. *Verandah Wall Plates.*—(See *Figs.* 25 to 30, *Plate* III.).

Corbels, 6′ c. to c.

Assume beam $3''\times 4''$, with four rods $\frac{1}{4}''$ diameter.

Effective section, $3''\times 3\frac{1}{4}''=9\cdot 75$ square inches.

Section of armour, $\cdot 196$ square inch $=2$ per cent., nearly, at centre.

$$\therefore\quad bd^2=\frac{WL}{120},\ b=3'',\ d=3\tfrac{1}{4}'',\ L=5\tfrac{1}{2}''.$$

$$\therefore\quad W=3\times\frac{13}{4}\times\frac{13}{4}\times\frac{120}{11}\times 2$$

$$=691 \text{ lbs. distributed}$$

Actual load applied,

$$=6\times\tfrac{1}{3}\times 12\times 30=720 \text{ lbs. distributed, or } 360 \text{ lbs. central.}$$

This is not considered excessive for the wall plates as above, which are supported, by the thrust of the rafters, against the wall.

Armour formed into skeleton and tied with wire; $\frac{5}{8}''$ diameter hole at centre for dowel bolt, and notches for ditto at ends.

(P.S.—A few wall plates, made as above, having cracked through the central hole, from mishandling in erection, two additional pieces of $\frac{1}{4}''$ rod, 3′ 6′ long, are now fixed to complete the upper longitudinal armour).

Digitized by Google

# *MODERN SEWAGE DISPOSAL.*

*By* CAPT. AND HON. MAJOR G. B. WILLIAMS, R.E. (T.).

THE recent publication of the fifth report of the Royal Commission on Sewage Disposal marks an important stage in the progress of modern ideas on the subject of the purification of sewage. The Commission was appointed in 1898, and since then its members have examined a number of witnesses, visited many sewage works, and, with the assistance of a special staff of experts, carried on a most valuable series of experiments and investigations, with a view to throwing light on many of the more obscure aspects of the question.

The results of their labours are embodied in a series of reports issued between 1901 and this year. The fifth report is the final and much the most important one of the series, and is practically a compendium of recent experience on the subject. Some of the conclusions which they have arrived at, after carefully sifting the mass of evidence which has come before them, are now published for the first time, and are of great value; and although they have not achieved the impossible—by succeeding in prescribing a perfect system of sewage disposal—they have suggested certain material modifications in the methods of bacterial treatment at present in vogue; and the effect of these and other of their recommendations will probably be seen in the improvements in future sewerage schemes, which a sounder and more scientific understanding of the problems involved will suggest.

Their general conclusion is so concisely stated at the commencement of the fifth report that it is worth while quoting it verbatim.

"We are satisfied that it is practicable to purify the sewage of towns to any degree required either by land treatment or by artificial filters, and that there is no essential difference between the two processes, for in each case the purification, so far as it is not mechanical, is chiefly effected by means of micro-organisms; the two questions therefore to be considered in the case of a town proposing to adopt a system of sewage purification are, first, what degree of purification is required in the circumstances of that town, and of the river and stream into which its liquid refuse is to be discharged; and second, how the degree of purification can, in the particular case, be most economically obtained.

Digitized by Google

The choice of a scheme must depend on a number of considerations which will be discussed later, but we may here state that we know of no case where the admixture of trade refuse with the sewage makes it impracticable to purify the sewage either upon land or by means of artificial processes, although in certain extreme cases especial processes of preliminary treatment may be necessary."

At first sight it might appear from these two statements, that the Commission consider that the sanitary expert should now be able to completely solve any problem placed before him involving the purification of the sewage of a community. The subsequent pages of the report correct this impression, and although it is undoubtedly true that, with unlimited funds and suitable surroundings, it would be possible to take a typical sewage, and by passing it through a series of processes finally convert it into pure water, such an operation does not usually come within the bounds of practical politics. It can by no means be said that an end to the difficulties of the sanitary engineer is as yet in sight.

While Royal Engineer officers have frequently to face sanitary problems, it is doubtful whether in many cases they can find time to study the mass of technical literature on the subject of sewage disposal, or to keep themselves informed of the rapid development of ideas which has taken place during recent years. The writer therefore ventures to put on record a short account of the principles of modern sewage purification, prefacing it with a brief historical sketch of the subject, and adding a detailed description of a small sewage disposal works, as an illustration of the practical application of these principles on a typical scale.

It is impossible in a paper of this description to go into the question of sewage disposal in any other country but our own, for in other climates and amongst less civilized communities the problems often present themselves in a quite unfamiliar form. Nor is it the writer's intention to discuss any of the other questions of public health with which sewage disposal is connected. Within the narrow limits indicated there is more than sufficient important matter to occupy a paper such as this.

*Earliest Examples of Sewage Works.*—Something in the nature of sewage disposal works was in use at an early period of history. In pre-Christian times several of the larger cities had some kind of sewers. Rome, Carthage, Alexandria, and Jerusalem are examples, and the latter town had a complete system of flushing water which irrigated the gardens in the city; there also appears to have been some kind of outfall works, consisting of a pool or tank, where the sewage collected, and whence it was taken by gardeners, who purchased it for manuring the soil of their gardens.

During the dark ages which followed the fall of the Roman Empire ideas on the question of sanitation were extremely primitive.

Digitized by Google

During the Renaissance period there were slight signs of improvement, but the progress made in these matters during the 16th, 17th, and 18th centuries was very slow, and it was not until the commencement of the 19th century that anything in the shape of a sanitary system can be really said to have existed at all.

At that time in large towns a certain number of underground culverts existed, conveying the streams which had at earlier periods flowed down open water courses alongside the streets. Although these culverts were not recognized as sewers according to modern ideas (prior to 1815 it was illegal to pass fæcal matter into the London sewers), they were the recipients of the effluent from cesspools and much other filth of all description. It is certain that they were very offensive from an early period of their existence, in fact it was the reason for their being covered up.

With the improvement in the system of water supply and the introduction of water-closets (which took place about 1810), the quantity of sewage proper rapidly increased, and its discharge into rivers and streams began to cause an intolerable nuisance to persons living on the banks. It became evident that it would be necessary to adopt some method of treating sewage so as to get rid of this nuisance.

The fertilizing powers of animal excreta had been long recognized and the deodorizing properties of soil are very evident, so it was natural that the first system of treating sewage should have been to apply it to land.

The earliest example of a sewage farm was on the Craigentenny Meadows near Edinburgh, a tract of land some 300 or 400 acres in extent, lying near the Firth of Forth. Some of the Edinburgh sewage was applied to this land as early as the middle of the 18th century, but the sole object of doing so was to obtain a profit, and the amount of purification obtained was extremely small or non-existent. According to modern standards, the Craigentenny sewage farm was never satisfactory.

In the early part of the 19th century attempts to purify sewage, by applying it to land on the system known as "broad irrigation," were made at Rugby, Croydon, and Macclesfield with a certain amount of success.

*Public Enquiries during the 19th Century.*—In the meantime the question of sewage disposal commenced to excite public interest; the object of the interest however was not so much the preservation of the public health as the realization of the profits which it was imagined could be obtained from the fertilizing properties of the sewage itself.

In 1821 the first public enquiry into the question of sewage disposal took place. Since then there has been a continual series of these enquiries—Royal Commissions, Parliamentary Committees, Departmental Committees, Committees of Experts, some of the latter

Digitized by Google

appointed by Government, others by corporations of towns or by scientific societies. All these undertook exhaustive investigations, but with little satisfactory results until the Commission at present sitting was appointed. They merely served to illustrate the complete divergence of opinion which has at all times characterized the evidence of experts on nearly every point in connection with this subject.

*Introduction of Chemical Precipitation.*—In 1846 the first process of precipitating the solid matter in sewage by lime was introduced by a Mr. Higgs, and was followed by all kinds of patents for chemical precipitation. The objects of all these were the precipitation of the solid matter in sewage by means of chemicals, the production of what was expected to be a useful manure, and the deodorization and purification of sewage to such an extent that it could be safely turned into a stream along with the surface water.

It soon came to be realized however that the improvement in the effluent by means of any of these processes is much more apparent than real. Practically only the putrescible organic matter in suspension is removed, that in solution remaining untouched. The solids in solution subsequently decompose, and if the effluent is turned into a stream, cause a nuisance only less in degree than that caused by the sewage itself.

The expectations of profit from the sale of sludge as manure were also not fulfilled. Out of 17s. per 100 tons, which the Royal Commission of 1882 considered to be the theoretical value of sewage for farming purposes, they estimated that 15s. belongs to the matter in solution and only 2s. to that in suspension. The cost of precipitating the latter and the mass of extraneous matter with which it is mixed when the process is complete prevents the operation from being a profitable one. The Commission of 1882 went so far as to express some doubt whether there was any manurial value whatever in sludge, or whether it was not a worthless product to be got rid of in the easiest way possible.

The present Commission have, in conjunction with the Board of Agriculture and Fisheries, carried out a number of experiments with a view to throwing light upon this question. These experiments, which are still being continued, show that sludge has undoubtedly some manurial value, and that the question of its economic use as a manure depends to a large extent upon the cost of carriage.

As a complete purification process, chemical precipitation proved a failure; but the disfavour into which it fell after the introduction of the septic tank was not entirely deserved, and as a preliminary process it may in many cases offer advantages over other methods of getting rid of the suspended solids.

*Evolution of the Bacterial Filter.*—In 1870 Dr. Frankland, who was at that time a Member of the Royal Commission on Pollution

Digitized by Google

of Rivers, commenced to devote his attention to a process of land treatment, to which the somewhat clumsy and meaningless term "intermittent downward filtration" was applied. A much larger quantity of sewage could be dealt with per acre by the new method than by the older system of "broad irrigation." An exaggerated idea was however held in the first instance of the quantity that could be purified. It was thought that the crude sewage of 2,000 to 3,000 persons could be dealt with on an acre of land, but subsequent experience has reduced this to 1,000 persons per acre.

The introduction of land filtration marks an interesting stage, for although the action of bacteria in purifying sewage was not understood at that time, this process was the precursor of the modern biological filter.

The experiments of Pasteur in 1857 had shown that lactic fermentation depends on the presence of minute organisms. Pasteur and Cohn also pointed out that putrefaction is a special case of fermentation, but for many years no effort was made to control those operations of nature by which organic matter is broken up into less complex substances, nor was it realized that the bacteria play an equally important part in the final stages of the transformation of animal and vegetable matter into harmless substances, such as when the carbonate of ammonia in sewage is oxidized into nitrites and nitrates, which in turn become food for plants.

In 1882 Warrington pointed out that solutions of ammonium salts would not undergo nitrification if they were sterilized, and foreshadowed the construction of artificial filter beds having greater oxidizing power than ordinary soil.

The next stage in the evolution of the sewage filter was the introduction of contact beds by Dibdin, after a series of experiments at the London Outfall Works at Barking. The mode of operating these beds by alternately filling them, then letting them stand full, subsequently emptying them and allowing time for them to "aerate," is now well known, so it is unnecessary to enter into a detailed description. Dibdin at first maintained that the whole process of purification could be performed by these beds, but it is now recognized that the idea that crude sewage can be applied to them, without any form of preliminary treatment, with any prospect of success, is a fallacy.

The most recent form of sewage filter is the percolating bed, over which the sewage is sprayed, either continuously or intermittently, by means of fixed or moving distributors of various kinds.

*Anaerobic Tanks and Sedimentation Tanks.*—The earliest method of liquefying the suspended solid matter in sewage under anaerobic conditions, with the object of getting rid of it by natural agencies, adopted on a practical scale, was that of Scott-Moncrieff, who in 1891 succeeded in reducing the suspended solids by passing sewage through an upward flow tank filled with coarse flints.

Digitized by Google

The introduction of the septic tank proper took place in 1896, when Cameron commenced to treat a portion of the Exeter sewage in a closed cemented watertight tank, subsequently passing the effluent through contact beds. The ideas at first held with regard to the quantity of sludge got rid of were undoubtedly too large. It is now found that somewhere between 10 per cent. and 30 per cent. of the total sludge is either decomposed into gases, or else liquefied and broken down into simpler substances. The claims originally made on behalf of the septic tank, that it digested practically all the organic solid matter and destroyed any pathogenic germs in the sewage, have certainly not been substantiated. As far as the latter claim is concerned, it appears to have practically no foundation at all, for sewage issuing from a septic tank is bacteriologically almost as impure as that entering it.

The failure of the septic tank to come up to the expectations of its introducers has led in some instances to a reversion to the system of precipitation as a preliminary to final filtration, the difference being that the settlement is now frequently allowed to take place without any assistance from chemicals, and is called "sedimentation." An example of a "sedimentation tank" is the "Dortmund," which is a circular tank with a conical bottom. In this the sewage is introduced at a considerable depth below the surface and flows upwards to an effluent pipe near the surface. The sludge makes its way to the bottom of the cone, and is removed at frequent intervals by means of a pipe, through which it is forced by the difference in head between the sewage in the tank and the outlet of the sludge pipe.

Recently a certain number of persons have gone so far as to deny that any digestion of sludge at all takes place in the septic tank, or in fact that the bacteria play any important part in the purification of sewage, and that the work is done by chemical, physical, or electrical agencies. Although it is quite possible that surface attraction, chemical action, and electricity all take some share in the complex series of changes which take place, the denial of the part taken by the bacteria is as extravagant as the pretensions made by the septic tank enthusiasts that all pathogenic germs were destroyed in their tank.

*General.*—A general review of the gradual development of the science of sewage purification shows us that with the introduction in turn of the various methods of treatment—land irrigation, land filtration, chemical precipitation, septic tanks, sedimentation tanks, contact beds, and percolating filters—there has been a constant tendency on the part of the introducers of a new system to exaggerate the benefits to be obtained by its adoption. On the other hand, there have been opponents in each case who have seen real and imaginary defects in the particular system to which they objected, which have

Digitized by Google

frequently appeared to them to be far more serious than was actually the case. It may be said that each of the processes mentioned above is capable of performing useful work, but that under ordinary circumstances no single process is capable by itself of economically purifying sewage to the degree necessary to satisfy modern standards. The combination of two or more processes, if the works are properly designed, can produce an effluent sufficiently pure to turn into an ordinary stream or water course, providing the works are intelligently and scientifically managed; and it cannot be too frequently emphasized that no purification works, however well designed, will continue to work satisfactorily unless they are under proper supervision.

*Objects of Purifying Sewage.*—Before entering into any practical details of the actual works required under various conditions it is necessary to describe briefly what sewage consists of and the objects to be achieved in purifying it.

The chemical composition of sewage varies greatly in different places, and also at the same place at different times. The solids are chiefly excretory substances, household waste, grit and detritus from roads. Nitrogenous and carbonaceous matter, ammonia, chlorine, and many other substances are present in varying proportions. In towns, where trade wastes are admitted in large quantities, an endless number of other chemical compounds may be added, occasionally considerably increasing the difficulties of purification.

If an unpurified sewage is discharged into a stream or river its injurious effects may be generally classified under four heads:—(1), The deposition of solid putrefying matter on the bottom and sides of the river; (2), the absorption of the dissolved oxygen in the water, which may render it impossible for fish to exist in the polluted stream; (3), the promotion of the growth of sewage fungus or other objectionable vegetation; (4), the discharge of pathogenic germs into the river.

In the case of a comparatively large volume of sewage discharged into a small stream, the latter may become an open sewer and a general nuisance to the neighbourhood. This is an extreme case and includes all the evil effects enumerated.

Taking the fourth injurious effect first, the presence of disease germs can only be a danger in potable water, or in water from which articles of food, such as watercress or shellfish, are taken and consumed uncooked. The difficulty and cost of treating all the sewage of a town in such a way as to sterilize it is very considerable, and, as far as the writer is aware, has never yet been attempted on a practical scale. Although the effluent from a first-class sewage farm shows a very large reduction in the number of micro-organisms as compared with the crude sewage, and a good artificial filter also diminishes their number greatly (but not to the same extent), nevertheless pathogenic germs are liable to find their way through the soil of the farm or the material of the filter, and if the effluent were to

Digitized by Google

be turned into a stream from which water is used for drinking without filtration, would form a serious danger.

The Royal Commission have carefully considered the practicability of treating sewage so as to render it bacteriologically pure, and for several weighty reasons, set forth in their fifth report, do not feel justified in recommending that it should be the duty of a local authority to do so. The idea of obtaining a bacteriologically pure effluent may therefore be at once dismissed as being a refinement rarely required.

With regard to the question of growths in streams, all sewage effluents contain a certain amount of plant food in solution, and therefore tend to promote vegetable growths; but in the case of well-purified and nitrated effluents these are green, and although under certain conditions they may give rise to nuisance, they are much less objectionable than the grey sewage fungus which makes its appearance in streams receiving imperfectly purified effluents.

The problem of purifying sewage is thus narrowed to the necessity of removing the suspended solids, and of producing an effluent whose capacity for absorbing oxygen has been so far diminished that it is not liable to cause any serious reduction in the quantity of oxygen dissolved in the water into which it is discharged.

These results are obtained by the precipitation or liquefaction of the suspended solids, and the oxidation of the carbonaceous and nitrogenous organic matter into harmless chemical compounds.

The first of these processes is partly or wholly a mechanical one. The second is the result of bacterial fermentation under aerobic conditions.

*Removal of Grosser Suspended Solids.*—In practice the removal of the suspended solids is usually accomplished in two or more operations, the first being the elimination of the heavier mineral matter, such as grit and road detritus, by settlement in detritus tanks, and the removal of grosser floating substances, such as sticks, cloths, paper, corks, scrubbing brushes, etc., by passing the sewage through coarse screens.

The detritus tanks are usually constructed to take about half-an-hour's dry-weather flow, and should be in duplicate. The greater part of the organic suspended solids are carried through these tanks, leaving the mineral matter behind.

The Automatic Sewage Distributors Company have introduced a tank which is a combination of a detritus tank and an upward flow sedimentation tank. The sewage enters the tank, which is circular, at the top, through a tangential inlet pipe, and first flows downwards, then passes under a circular baffle plate, and finally upwards through the inner space inside this ring. The sludge is removed by a travelling sludge pipe, which moves round the bottom on a spindle worked by gearing from the top.

Digitized by Google

*Precipitation and Septic Tanks.*—The removal or liquefaction of the organic solids in suspension is the next step, and this operation may either be performed by septic tanks, by chemical precipitation, or by settlement without the aid of chemicals (sedimentation).

Considerable confusion has been caused by the misuse of the latter term, which has sometimes been applied to tanks intended to work on the septic system and sometimes to detritus tanks. It is rather difficult to draw a hard-and-fast line between sedimentation tanks and septic tanks, for the action of the latter depends to a large extent on the settlement of the solids, and in the former there is a certain amount of septic action. The effect of this however is not important if the sludge is removed at comparatively short intervals, and consequently more sludge is produced than with the septic tanks.

If the quiescent system of sedimentation is adopted, that is turning sewage into the tank, letting it stand for two or three hours, and then draining off the clarified liquid, the quantity of sludge is still greater, whilst with chemical precipitation it is obviously further increased. The facilities for disposing of sludge are therefore important factors in the choice of a system of preliminary treatment.

*Comparison of Different Preliminary Processes.*—The portion of the Royal Commission's report which deals with the preliminary processes is particularly illuminating, and will probably have the effect of restoring chemical precipitation to favour in many cases. The Commission have come to the conclusion that out of 35 parts per 100,000, which may be taken as the average amount of suspended matter in ordinary domestic sewage, the amount left in the tank liquor after chemical precipitation is from 1 to 6 parts, according to the process adopted, after quiescent sedimentation, from 5 to 8 parts, and after continuous flow sedimentation or septic tanks, from 10 to 15 parts per 100,000. It is thus clear, notwithstanding the statements to the contrary which have been so confidently made, that chemical precipitation is a more efficient process for removing suspended solids than either sedimentation or septic tanks. It is however much more expensive, and the difference is particularly great in a small disposal works, where the cost of additional labour is greater in proportion to the other annual charges than in larger works.

For the same reason the system of quiescent sedimentation, which requires constant labour for emptying the sludge, is not suitable for small works, although in large ones it costs very little more, and, according to the Royal Commission, gives considerably better results than continuous flow sedimentation.

For small towns and villages the choice of an economical system of removing the suspended solids is limited to the septic tank and the different types of continuous flow sedimentation tanks, and will be largely determined by the question as to whether it is easy or difficult to dispose of the sludge.

Digitized by Google

*General Conclusion as to the Septic Tank.*—One of the most important claims advanced on behalf of the septic tank has been that the effluent is more easily oxidized than sewage which has passed through chemical precipitation tanks or sedimentation tanks. Experiments carried on by the Royal Commission have proved that it has no advantage in this respect over the other methods.

The following sentence shows the general conclusion arrived at by the Commission with regard to the septic tanks :—

"It must therefore be said that some of the more important claims which were originally advanced in favour of septic tank treatment have not stood the test of experience. At the same time we think that in certain circumstances the adoption of this mode of treatment as a preliminary process is efficient and economical."

*Other Forms of Preliminary Treatment.*—The form of sedimentation tank, known as the Dortmund tank, has been already referred to. Various forms of upward-flow tanks have been used, and have been comparatively successful, although they are not free from defects. In Birmingham the liquor from the septic tanks is passed through Dortmund tanks before final purification, and the suspended solids are reduced by this means from 20 parts to 6 parts per 100,000.

A tank for removing the suspended solids has been in operation at Hampton for some time, and has been given the name of "hydrolytic tank." A description appears in the *Minutes of Proceedings of the Institution of Civil Engineers*, Vol. CLXIV.

The authors of the descriptive paper held somewhat fantastic notions with regard to the purification of sewage, alleging that the process is in the main the result of physical operations, and that bacteria only play a subsidiary part. These remarkable statements were made on the basis of very slender evidence, and apparently the only scientists who have agreed with them are the German chemists, W. Biltz and O. Kröhnke. The paper was however of value, for it drew attention to the fact that many of the solids in sewage are in a colloidal state, or in semi-solution, and that under certain conditions these colloids subsequently tend to become particulate. The hydrolytic tank is a somewhat complicated arrangement, and it is permissible to doubt whether, under the circumstances, it is likely to come into general use.

*Final Treatment.*—The final purification of sewage can be accomplished by passing the tank effluent through or over land, or by treatment in contact beds, or in some form of percolating filter. Of these three alternative methods there is little doubt that, under really favourable conditions, land treatment holds the first place for efficiency.

The effluents from the best land are both chemically and bacteriologically superior to those from artificial filters. Further, the preliminary treatment need not be so thorough as for filters, although

Digitized by Google

some form of preliminary treatment is always desirable. When really good land can be obtained within a suitable distance and at a reasonable price, land treatment may be cheaper than artificial filters, but such cases are the exception in England, and when these conditions do not occur artificial filtration is more economical.

The relative merits of contact beds and percolating filters have been fully discussed during the past six years. The decision arrived at during that time by the majority of sanitary engineers who have had experience of both methods has been fully borne out by the Royal Commission.

In the fifth report they state that "a cubic yard of material arranged in the form of a percolating filter will generally treat satisfactorily nearly twice as much tank liquor as a cubic yard of material in a contact bed."

This being the case, it is not necessary in this paper to enter into further details with regard to contact beds, for although in some minor respects they have advantages over percolating filters, these are certainly not usually sufficient to outweigh the greater economy and efficiency of the latter.

*Percolating Filters.*—The sewage may be distributed over a percolating bed either (*a*) by a moving distributor, driven automatically by the head of sewage or by applied power; or (*b*) through fixed pipes by means of spraying nozzles or a number of small orifices; or (*c*) through dripping trays or tipping troughs, both of which are special forms of fixed distributors; or (*d*) the distribution may be effected by a layer of fine material on the top of the bed.

None of these methods are perfect, and each has its own special form of disadvantage. For a small sewage works the writer considers a moving distributor driven automatically to be the best type. The most common sprinkler is a revolving one on a circular filter bed. The details of a sprinkler of this kind will be described in the next part of the paper, and in the meantime it is only necessary to say that it is liable to considerable interference from a strong wind unless shielded from it, and that the numerous holes in the revolving arm require daily attention, otherwise they get stopped up. Nevertheless, there are many examples of these sprinklers working satisfactorily at the present time.

A form of sprinkler which has been more recently introduced travels up and down on rails over a rectangular bed. This distributor works on the principle of an undershot bucket water wheel. In one part of the apparatus the buckets are set in one direction and in the other part in the opposite direction; when the distributor reaches the end of the bed a valve is automatically reversed and causes the sewage to flow on to the opposite side of the distributor, which then travels back again. The disadvantage which would appear to attend the use of this form of distributor is that the distribution is not so even as

Digitized by Google

with the revolving arms, being more of the nature of a concentrated flow during a very short period on each part of the bed at comparatively long intervals of time.

After filtration the final operation is the settlement of the suspended matter, which works its way through the filters and is washed out with the effluent. This matter, which is unobjectionable, and in appearance similar to the humus of soils, is deposited in a small humus pit, or chamber, and the final effluent should then be pure enough to pass into an ordinary stream or river.

*Amount of Purification Effected.*—It is next necessary to consider the degree of purification required and how the amount of purification effected is to be measured. Chemical analysis of a typical domestic sewage of medium strength would probably give some such result as the following :—

| | | | | | |
|---|---|---|---|---|---|
| Ammoniacal nitrogen ... ... | 5 | parts | per | 100,000 | |
| Albuminoid nitrogen ... ... | 1 | ,, | ,, | ,, | |
| Oxygen absorbed in 4 hours ... | 10 | ,, | ,, | ,, | |
| Suspended solids... ... ... | 35 | ,, | ,, | ,, | |

The Royal Commission denotes the strength of a sewage by the number of parts by weight of dissolved oxygen which 100,000 parts of the liquid would take up during the complete oxidation of all the oxidizable matter contained in such liquid. The number is obtained by a calculation according to a formula suggested by Dr. McGowan.

This formula is (for sewage and septic tank liquors) :—

$$(\text{Ammon. N} + \text{Organic N}) \times 4{\cdot}5 + (\text{Oxygen abs. in 4 hours} \times 6{\cdot}5).$$

The strength of the typical sewage above referred to would be about 110.

In order to compare the amount of purification effected at different places Dr. McGowan had also devised a unit of purification.

To express the number of units of purification effected by a filter, the number of parts by weight of oxygen taken up by 100,000 parts of the effluent during complete oxidation is deducted from the number of parts by weight of oxygen taken up by 100,000 parts of the tank liquor, and the number so obtained is multiplied by the number of gallons of liquor per cubic yard passing through in 24 hours. The number of parts of oxygen which an effluent will take up is calculated from the formula :—

$$(\text{Ammon. N} + \text{Organic N}) \times 4{\cdot}5 + \text{Volatile matter of susp. solids} \times 2 - \text{Nitric Nitrogen} \times 3.$$

Digitized by Google

The sewage previously referred to would give, after complete treatment, some such chemical analysis as the following :—

| | | | | |
|---|---|---|---|---|
| Ammoniacal nitrogen ... ... | ·50 | parts | per | 100,000 |
| Albuminoid nitrogen ... ... | ·10 | ,, | ,, | ,, |
| Oxygen absorbed in 4 hours ... | ·90 | ,, | ,, | ,, |
| Nitric nitrogen ... ... ... | 1·5 | ,, | ,, | ,, |
| Suspended solids ... ... | 2·0 | ,, | ,, | ,, |

The strength of this sewage would be about 2.

The strength of the tank effluent would probably be about 85, and, if the filtration was being carried on at the rate of 100 gallons per cubic yard per day, the number of units of purification would be 83 × 100=8,300 units.

The Royal Commission give the following Table as an approximate idea of what number of units of purification per cubic yard may be expected from different forms of treatment :—

| | Units of Purification per cubic yard. |
|---|---|
| Crude or partially settled sewage treated on contact beds. | 3,000 to 4,000 |
| Crude or partially settled sewage treated on percolating beds. | 2,500 to 3,500 |
| Well-settled sewage treated on percolating filters. | 7,000 to 8,000 and probably up to 11,000 |
| Septic tank liquor treated on single contact beds. | 3,000 to 4,500 |
| Septic tank liquor treated on double contact beds. | 3,000 to 4,500 |
| Septic tank liquor treated on percolating filters | 7,000 to 11,000 |
| Precipitation liquor treated on single contact beds. | Up to 11,000 |
| Precipitation liquor treated on double contact beds. | Probably up to 6,000 or 7,000 |
| Precipitation liquor treated on percolating filters— | |
| (*a*). Filters of coarse material ... | Up to about 8,000 |
| (*b*). Filters of fine material ... ... | Up to about 18,000 |

*Rates of Filtration.*—The Royal Commission have gone very fully into the question of how much sewage can be purified successfully per cubic yard of filter. Hitherto the rule adopted by the Local Government Board in sanctioning loans for sewage works has been to insist, in the case of percolating filters, that the rate of flow is not to exceed 56 gallons per square yard of surface of filter per foot in depth, or 168 gallons per cubic yard, when the filter is treating the maximum quantity (usually three times the dry-weather flow).

Digitized by Google

This standard has been generally quite strict enough, but a more elastic one is necessary, for a hard-and-fast rule takes no account of the strength of the original sewage, the nature of the preliminary treatment, nor the fineness or coarseness of the filter to which the tank effluent is to be applied.

The conclusion of the Royal Commission with regard to the rates of filtration through percolating filters may be summarized as follows :—

| | Gallons per cubic yd. per day Average Dry-Weather Flow. |
|---|---|
| *Coarse Material (3″ diameter and upwards).* | |
| Tank liquor containing 1 to 4 parts per 100,000 | 150 to 200 |
| do. do. 4 to 7 do. do. | 100 to 150 |
| do. do. 10 to 20 do. do. | 100 |
| Partly settled and screened sewage containing 30 parts per 100,000 ... ... ... | 50 |
| *Medium Material (½″ to 1″).* | |
| Tank liquor containing 1 to 4 parts per 100,000 | 150 to 200, providing the filters are carefully rested when necessary. |
| do. do. 4 to 7 do. do. | 75 to 100 |
| do. do. 10 to 15 do. do. | 50 |
| Partly settled and screened sewage containing 30 parts per 100,000... ... ... ... | 25 |
| *Fine Material (¼″ diameter).* | |
| Tank liquor containing 1 to 4 parts per 100,000 | 150 to 200 |
| do. do. 4 to 7 do. do. | 75 to 100 |

It would be inadvisable to try to filter tank liquors containing more than 6 or 7 parts per 100,000 on material as fine as this.

The above figures relate to ordinary domestic sewage of average strength.

*Stormwater Treatment.*—The question of the quantity of storm-water which it is necessary to deal with depends largely on the system adopted. It is obvious that where all the surface water is taken into the sewers the rainfall has a proportionately greater effect in increasing the flow of sewage than with a partially separate system, whilst with a completely separate system the increase in wet weather is very small.

The Royal Commission do not look with any favour upon the separate system, and give several reasons for their objections to it.

Digitized by Google

At the same time it is doubtful if they have clearly realized the engineering difficulties which the adoption of the combined system occasionally involves. In any case there are certainly some places where the separate, or partially separate, system is the obviously suitable one.

Whether the sewers are on the combined or on the partially separate system they will discharge many times the dry-weather flow in wet weather at the sewage works. It is therefore necessary to make provision there for dealing with the stormwater. The method which has hitherto been generally adopted has been to arrange that during rain storms an increase of the flow of sewage up to three times the dry-weather flow should go through complete treatment, and that an additional quantity of three times the dry-weather flow should be filtered through stormwater beds at the rate of about 500 gallons per square yard of filter per day. The depth of material in these beds is usually about 3′.

In this way a total of six times the dry-weather flow is treated. The remainder of the stormwater passes untreated into the streams, either through storm overflows spaced at intervals along the sewers, or at an overflow at the end of the main outfall sewer at the disposal works.

It has been recognized that this method of dealing with stormwater is in most cases not a very satisfactory one. The stormwater filter, if, as is generally the case, it is only in use at intervals, is never in a good biological condition, and has therefore hardly any oxidizing power. It merely acts as a straining bed and removes some of the grosser solids. The first flush of stormwater during heavy rain after dry weather is exceptionally impure, worse, in fact, than the dry-weather sewage, and in many of the existing sewerage schemes large quantities of suspended solids, some of them of a grossly polluting nature, are liable to be discharged into the streams during rain storms.

The Royal Commission recommend that the following provisions for treating stormwater should be made, in place of those usually adopted :—

(1). That special stand-by tanks (two or more) should be provided at the works and kept empty for the purpose of receiving the excess of stormwater, which cannot properly be passed through the ordinary tanks. As regards the amount which may be passed through the ordinary tanks, our experience shows that in storm times the rate of flow through these tanks may usually be increased up to about three times the normal dry-weather rate without serious disadvantage.

(2). That any overflow at the works should only be made from these special tanks, and that this overflow should be arranged so that it will not come into operation until the tanks are full.

(3). That no special storm filters should be provided, but that the ordinary filters should be enlarged to the extent necessary to provide

Digitized by Google

for the filtration of the whole of the sewage, which, according to the circumstances of the particular place, require treatment by filters.

(4). As regards the overflow from the outfall sewer to the stand-by tanks, the size of the stand-by tanks, the amount of storm sewage which should be filtered, and the arrangement generally for dealing with storm sewage at the outfall works, the Rivers Boards, or the County Council in areas in which no Rivers Boards have been established, should have similar powers to that which we have proposed in regard to overflows on branch sewers, and the local authority should have a similar right of appeal to the central authority.

In a previous paragraph of the report it is stated : -" We think it may be taken that it is practicable to filter three times the mean dry-weather flow, and while there are few or no data to show that this is the right amount for which filtration is required, we doubt whether as a general rule the filtration of any larger amount will be found to be necessary to prevent nuisance."

In another paragraph we find :—" We have not sufficient experience to enable us to suggest by what means the capacity of the stand-by tanks should be determined, but we should think that tanks capable of holding a quarter (six hours' flow) of the mean daily dry-weather flow would usually be sufficient."

These recommendations will probably lead to much discussion, but in the writer's opinion the treatment suggested, viz., three times the dry-weather flow to be passed through the ordinary tanks and filters, and the remainder of the stormwater to undergo a partial settlement in a tank holding six hours' flow, will not be found sufficient.

The rate of flow of the dry-weather sewage fluctuates from hour to hour throughout the day, and may during several consecutive hours be more than one and a-half times the average rate. At such a time a comparatively small amount of rainfall would (especially in the case of a combined system) add sufficient surface water to bring the quantity of sewage up to more than three times the dry-weather flow, and the resultant mixture of sewage and stormwater would in most cases not be sufficiently inoffensive to turn into a stream after only undergoing a partial settlement in a subsidence tank.

It will probably be found in practice necessary to filter more than the suggested quantity of three times the dry-weather flow.

It is of course impossible to arrange to treat all the stormwater which might possibly arrive at the outfall works during very heavy rain storms, for in some places this might amount to 20 or 30 times the dry-weather flow ; but it will probably be found necessary, in addition to giving three times the dry-weather flow the complete treatment, to pass a further quantity of three times the dry-weather flow through the filters after a settlement in the stormwater tanks. Anything in excess of six times the dry-weather flow would overflow

Digitized by Google

from the stormwater tank into the stream. The filters would have to be enlarged so as to deal with six times the dry-weather flow. The extent to which this would necessitate their area being increased will be discussed later.

*Quantity and Strength of Sewage and Form of Treatment.*—An example of a sewage disposal works for a small town has been worked out in detail in order to illustrate some of the principles involved in the design of modern sewage purification works. Although the example is not altogether taken from actual practice, it is typical of many cases which arise, and includes some improvements suggested by the Royal Commission's Report.

The town for which the works are to be provided is supposed to have a population of 3,000 persons, with a daily dry-weather flow of 25 gallons per head. The sewage is ordinary domestic sewage of medium strength, the figure being about 100, according to the Royal Commission's formula previously referred to.

The form of treatment adopted is septic tanks followed by percolating beds; the latter are of the circular type with automatic revolving distributors, the beds being 6′ deep. Plans and sections of the works are shown on *Plates* I. and II. The ground levels shown on the sections give a good fall.

The average dry-weather flow is 75,000 gallons a day. In wet weather the filters take three times this amount, or 225,000 gallons a day, after passing through the septic tanks, and an additional 225,000 gallons a day after settlement in the stormwater tanks. Everything in excess of this quantity overflows from the stormwater tank into the river.

*Sewer Outfall and Overflow Weir.*—The sewage discharged by the main outfall sewer flows along a short length of open channel before reaching the detritus tanks (*Plate* I.). On one side of this channel there is a weir so arranged that when the quantity of sewage exceeds three times the average dry-weather flow, the excess overflows into an adjoining channel communicating with the stormwater tank. It is hardly necessary to mention that it is important to make this weir, as in fact all overflow weirs, as long as is possible, in order that when discharging at the maximum rate the depth over the cill should be small, and the quantity of sewage passing along the main channel not much increased beyond the necessary three times the dry-weather flow. Even with a long weir this difficulty still occurs in a lesser degree, and in order to keep the maximum flow to the septic tanks during storms as near the limit as possible, a hand sluice is fixed in the channel and acts as an orifice gauge. This can be opened and adjusted so as to take a greater flow if necessary, but cannot be closed below a certain point.

*Detritus Tanks.*—The detritus tanks are in duplicate, each being semi-circular with a conical bottom. A separate plug valve is

Digitized by Google

provided for each tank in order to let out the sludge. Owing to the shape of the bottoms the deposited solids can be partially removed without emptying the tanks by raking them up the sloping sides. The capacity of each of the detritus tanks is 1,500 gallons, or about half-an-hour's flow. They are intended to be used separately, but in wet weather can be used in parallel.

The screens, which are formed of flat bars, set $\frac{3}{4}''$ apart, are placed at the outlet end of the detritus tanks and are fixed at a slope of 45°.

*Septic Tanks.*—The two septic tanks hold between them 75,000 gallons, or 24 hours' dry-weather flow. They are of concrete, faced with cement rendering, the channels and copings being of brickwork.

Each tank is divided into three compartments by two diaphragm walls; the walls nearest the inlet end are solid, and the others, which are intended for strengthening purposes, are pierced, so as to allow free communication through them. The first walls divide the tanks into two unequal portions from about 12″ below the top-water level, the compartments nearest the inlet end having a capacity equal to one-third the total capacity of the tanks. The object of the division is to enable the first, smaller compartments, in which the greater part of the sludge will be deposited, to be emptied without emptying the rest of the tanks. This arrangement forms practically a combination of a sedimentation and a septic tank, the first compartment being emptied at comparatively frequent intervals, and the second being allowed to run as long as possible. The sewage enters and leaves the tanks below top-water level through rows of pipes communicating with the external channels, the object being that there should be no disturbance of the surface.

*Stormwater Tank.*—The stormwater tank is rather larger than recommended by the Royal Commission, and holds one-third of the average daily dry-weather flow, or 25,000 gallons. It does not appear necessary in so small a works to follow out the suggestion that this tank should be divided into two. An overflow weir is provided from which the excess stormwater over three times the dry-weather flow goes direct to the stream. The occasion when this overflow weir is in use will be rare, and it will only come into operation after a storm has lasted for some time, and consequently the quantity of impurity is in a diminishing ratio and the streams are swollen with the heavy rain. At such a time the discharge of a dilute and partially settled mixture of stormwater and sewage will probably not be injurious. As has been previously explained, the provision made for treating stormwater is considerably more than that suggested by the Royal Commission. The settled stormwater, up to three times the dry-weather flow, is discharged into the outlet channel from the septic tank to the sprinklers.

After the stormwater tank has been in use it will be necessary to empty it, and for this purpose a floating arm is provided. The

Digitized by Google

liquid taken by the floating arm will have received a very complete settlement, but it will sometimes not be fit to turn into a small stream without some further treatment. In a place where there is considerable fall between the tanks and the filters it could be passed through the filters if a suitable time for doing so were chosen; but the ground levels as shown on the drawings do not admit of this. It is supposed that in these works a small area of land (from $\frac{1}{4}$ to $\frac{1}{3}$ of an acre would be sufficient) has been laid out for land filtration, and that the effluent from the floating arm will be discharged on to this land before passing into the stream.

The arrangement of sludge pipes and valves is clear from the plan. The sludge gravitates to the sludge disposal area, where it is either dried and disposed of to farmers or buried in trenches in the ground.

*Percolating Beds.*—The four filters have in wet weather to deal with six times the dry-weather flow, or 450,000 gallons a day. In dry weather they are to purify a septic tank liquor, which will probably contain from 10 to 15 parts of suspended solids per 100,000. For such an effluent a fairly coarse size of material would be desirable, in order to prevent clogging. A suitable material would be furnace clinker 1″ to 3″ diameter. Such a filter would be capable of purifying the average dry-weather flow at the rate of about 80 gallons per cubic yard per day, or, in this case, as the filters are 6′ deep, 160 gallons per square yard. The stormwater up to three times the dry-weather flow, coming through the septic tank, could be purified at twice this rate, or 320 gallons per square yard per day; and on the comparatively few occasions when it would be necessary to treat a mixture of septic tank liquor and stormwater from the stand-by tank up to six times the dry-weather flow this could be filtered at the rate of 500 gallons per square yard. In order to treat 75,000 gallons at the rate of 160 gallons per square yard, 468 square yards of filtering material would be required; for 225,000 gallons at the rate of 320 gallons per square yard per day, 703 square yards; and in order to deal with 450,000 gallons at the rate of 500 gallons per square yard per day, 900 square yards would be necessary. Each of the four filters will therefore have to be of an area of about 225 square yards, or a diameter of 50′.

The form of construction of the filters is clear from the drawings. The circular walls are of brickwork 9″ thick at the top and 14″ thick below the plinth course, strengthened by steel bands in segments bolted together. In some filters the walls are perforated with numerous holes to improve the aeration of the bed; it is however doubtful if these holes have any great effect, and the filters shown can be well aerated without them.

*Automatic Sprinklers.*—All the filters will in the general way be in use simultaneously, and there may thus be a variation in the quantity of sewage distributed over the beds, from a normal 83 gallons

Digitized by Google

per square yard per day in dry weather, up to an occasional 500 gallons per square yard in times of heavy rain storms. This possible variation presents some mechanical difficulty.

The type of distributor shown on the drawings gets over this difficulty in an ingenious fashion. Each sprinkler is fed from the central distributing chamber through an automatic syphon. In order to prevent some of the beds from doing more than their fair share of the work, the four syphons are connected to one air outlet pipe, and are arranged so that all discharge at the same time. Provision is made for cutting out one or more of the beds if necessary without disturbing this arrangement. The syphons are so adjusted that when the sewage is coming down at less than a certain rate (in this case about 200,000 gallons per day, when all the syphons are in work) they discharge at a greater rate than the inflow, and consequently work intermittently. With the ordinary dry-weather flow, the syphons would discharge for about 5 minutes, and then rest for about 8 minutes. When the flow of sewage increases beyond the rate of 200,000 gallons per day the syphons would act continuously. Up to this point only two out of the four arms of the sprinkler would have been in use, but an increase beyond the 200,000 gallons would cause the sewage to rise in the distributing chamber, and also in the bases of the sprinklers, until the level of an orifice overflow weir inside the latter was reached. This orifice connects with the other two arms, which are known as "compensation arms," and the four arms working together would be capable of taking the whole of the quantity of 450,000 gallons a day. The rates and times of working the sprinklers would be as follows:—

| Flow of Sewage, at Rate of | No. of Arms in Use. | Periods of Discharge. | Period of Rest. |
|---|---|---|---|
| 75,000 galls. per day | 2 | 5 minutes | 8 minutes |
| 200,000 ,, ,, | 2 | continuous | |
| 450,000 ,, ,, | 4 | ,, | |

There are several other types of circular sprinklers, many of which frequently give good results, but those described appear to adjust themselves more readily to considerable variations in the discharge than the others. It is claimed that the intermittent discharge of the dry-weather sewage has the effect of to some extent preventing growths on the surface of the filters, and also that the effluent is better nitrated.

*Underdrains and Humus Pits.*—The underdraining of the filters is an important consideration. The underdrains shown are semi-circular

Digitized by Google

stoneware drain tiles, arranged radially and discharging into a circular channel running round the filters. It is important that the lower part of the filters should not be liable to become waterlogged, and that means should be provided for a free passage of air through the interior of the beds.

The suspended solids which work their way through the filters are deposited in the humus pits. From these the effluent pipes connect with a junction chamber, from which a pipe discharges into the stream.

*Conclusion.*—Although the writer has confined himself in the last part of this paper to describing one particular form of sewage treatment, under certain arbitrary conditions, it is not suggested that this must necessarily be the most perfect scheme that could be devised even in the circumstances selected. It is merely intended to show a method of dealing with ordinary sewage, which experience and modern sanitary science have shown to be a comparatively efficient one. To enter into detail as to all the processes of which it would be possible to make use would fill a book of encyclopædic dimensions, and could not be attempted in a paper of this kind.

The operations necessary in dealing with sewage cannot under the most favourable circumstances be anything but more or less unpleasant ones. The idea that the sewage works can become pleasure resorts, at which the employees are engaged in transforming foul liquids into pure drinking water, is one that can be only fostered by interested persons for the benefit of credulous deputations from local authorities. The best that can be reasonably expected is that crude sewage should be purified to such an extent that no danger to health will follow its discharge into the stream, river, or tidal estuary, which is its natural outlet, and that the process should be carried on without causing any nuisance or inconvenience to persons living in the neighbourhood of the works.

How far existing works fall short of perfection, even when judged by these standards of efficiency, an inspection of any dozen disposal works selected at haphazard would at once show. The reasons why there have been so many failures amongst sewage schemes—more in proportion than amongst any other kind of engineering works—can be understood from a study of the history of the subject. Amongst others the following causes have contributed :—(*a*), Ignorance of the elementary principles on which these works should be designed ; (*b*), the notion that sewage disposal could be made a profitable operation ; (*c*), the misleading statements made by persons financially interested in certain processes ; (*d*), the extravagant ideas formed by enthusiasts about a new process ; (*e*), generalizing too freely from experiments made on a small scale or for an insufficiently long period ; (*f*), the prejudice, ignorance, and lack of intelligence of some local councils and their officials, and the interference of such

Digitized by Google

people with the work of their technical advisers; (*g*), bad management and neglect of the works; (*h*), dishonest and incompetent engineering.

This forms a fairly long list, but it could probably be extended. It is to be hoped that with the gradual spread of a more exact knowledge of the principles of sewage disposal, and of its limitations, these failures may continue to become fewer. In the meantime those concerned in this question can only adopt a cautious and conservative attitude and work slowly along the lines of progress which have already been laid down, in the direction of the attainment of the perfect system of sewage purification which may possibly in some remote future be arrived at.

Digitized by Google

# *THE R.E. HEADQUARTER MESS.*

(*Continued*).

*By* LIEUT.-COLONEL B. R. WARD, R.E.

In the south annexe the principal pictures consist of three full-length portraits of "Chinese" Gordon, the Duke of Cambridge, and Lord Kitchener. The portrait of Gordon—which is reproduced both as the frontispiece to the second volume of Porter's *History of the Corps*, and also in A. Egmont Hake's *Events in the Taeping Rebellion*—was painted by Mr. Val Prinsep, R.A., in 1867, and represents Gordon—then a Captain, R.E., and Brevet Lieutenant-Colonel—as a Mandarin wearing the Yellow Jacket, a distinction which was bestowed on him by the Emperor of China, after the suppression of the Taeping Rebellion in 1864.

None of our Corps heroes has attained to so high a position in the public estimation as General Gordon. Certainly no soldier since the time of the Duke of Wellington has been so transfigured in the national imagination. His statue in Trafalgar Square, the cenotaph in St. Paul's Cathedral, and the epitaph by Tennyson in Westminster Abbey, bear sufficient witness to this fact. Nor has the Corps to which he belonged been behindhand in doing honour to the national hero. In addition to Mr. Val Prinsep's fine portrait, we have in front of the Institute Onslow Ford's statue, a replica of which was set up in Khartoum in 1902. A bronze bust and a head and shoulders portrait are also in the Mess, and a plaster cast of the recumbent figure in St. Paul's Cathedral occupies the south side of the vestibule of the R.E. Institute. In fact there are at Chatham fewer effigies even of Sir John Burgoyne—best-beloved as he is of all our Corps heroes—than there are of General Gordon.

An interesting set of Gordon relics, including the famous Yellow Jacket, is preserved in the R.E. Institute. These will doubtless eventually find a fitting resting place in the R.E. Museum, which it is hoped may before long become more than a pious aspiration.

The literature about Gordon is very voluminous. The *Encyclopædia Britannica* contains an article by Sir Charles Watson, K.C.M.G., C.B., R.E., in Vol. XXIX., p. 31. The *Dictionary of National*

Digitized by Google

*Biography*, Vol. XXII., p. 169, contains another by Colonel R. H. Vetch, R.E. Many books about his Chinese exploits have been written, from Andrew Wilson's *Ever-Victorious Army*, published in 1868, to Egmont Hake's *Events in the Taeping Rebellion*, published in 1891.

His career in the Soudan has been still more frequently recorded. One at least of these books—*Colonel Gordon in Central Africa, 1874—1879*, by George Birkbeck Hill—was published during his lifetime in 1881, and since his death at Khartoum, in 1885, many more have been given to the world. He has not yet—like Stonewall Jackson—found a biographer whose *Life* throws all others into the shade. Doubtless succeeding generations will each require their own special version of his career and character, for, like Napoleon, Nelson, and Lee, his striking and commanding personality is certain to fascinate mankind for many an unborn generation.

The portrait of the Duke of Cambridge is by Hermann Herkomer. His Royal Highness was Colonel-in-Chief of the Corps as well as of the Royal Regiment of Artillery, from 1861 to his death in 1904.

He was born on the 26th March, 1819, and in November, 1837, was commissioned Brevet Colonel in the Army. During the Crimean War he acted as Lieutenant-General Commanding the 1st Division, and in 1856 he succeeded Lord Hardinge as General Officer Commanding-in-Chief. In 1862 he became a Field Marshal. In 1887 his title was changed to Commander-in-Chief, an appointment which he held until 1895. No one who ever attended the Corps Dinners—at which he constantly presided until within a very few years of his death—is likely to forget his cheery and humorous speeches, full of a certain blunt common sense, displaying as they always did an unfailing interest in the Corps.

On the 20th November, 1896, a year after his retirement from the Army, His Royal Highness presided as Colonel of the Corps at a dinner given at the Headquarter Mess in honour of Sir Herbert Kitchener and the R.E. officers employed under him in the Dongola Expedition. After the toast of the evening had been duly honoured, Field Marshal Sir Lintorn Simmons rose to propose the health of the Duke. "The fine portrait on the wall of the Mess," said Sir Lintorn, "will bring him to the minds of all of us, and will habitually recall the strong friend we have always had in His Royal Highness during the time he was Commander-in-Chief." In the course of his reply the Duke said he could only hope that in years to come, when he had passed away and they looked on that portrait, they would remember that they never had a sincerer friend and well-wisher to the Corps, or the British Army generally, than the individual who for 40 years ruled over and organized the Army.

Digitized by Google

On the 8th November, 1898, the Duke again presided at a dinner given at Chatham to Major-General Lord Kitchener, after the brilliant conclusion of the Soudan Campaign. In the same year it was decided that a picture of Lord Kitchener should be painted for the Chatham Mess. The picture was painted by Mr. A. S. Cope, and is now hanging in the south annexe.

On the 23rd July, 1902, the Duke of Cambridge presided for the third time at a complimentary dinner to Lord Kitchener, on his return to England on the conclusion of the South African War. The dinner on this occasion was held at the Hotel Cecil. In the course of his remarks the Duke said: "I do not think that in the list of British officers there is one, except the Duke of Wellington, who has rendered finer service to his country than Lord Kitchener."

In addition to the full-length portraits of General Gordon, the Duke of Cambridge, and Lord Kitchener, there are smaller portraits in the south annexe of Colonel Landmann, Colonel Sir Frederick Chapman, Colonel Sir John Bateman-Champain, another of General Gordon, and lastly one of General Sir John Ardagh.

Lieut.-Colonel George Thomas Landmann (1779—1854) was the son of a German who had served in the French Army as *aide-de-camp* to the Duc de Broglie during the Seven Years' War. In 1777, on the invitation of George III., Isaac Landmann assumed the position of Professor of Artillery and Fortification at the Royal Military Academy. This position he held for 38 years, until his retirement in 1815.

His son was born at Woolwich in 1779, entered the Royal Military Academy as a cadet in 1793, and obtained his commission as a Second Lieutenant in 1795. In 1806 he was promoted Captain, and in 1808 he joined Sir Arthur Wellesley in the Peninsula. He was present as C.R.E. at the Battles of Roleia and Vimiera on the 17th and 21st August, succeeding Capt. Elphinstone, who was wounded in the former battle.

In consequence of his knowledge of Spanish he was in 1809 granted a commission as Lieutenant-Colonel in the Spanish Engineers. In 1810 he was made a Colonel of Infantry in the Spanish Army, and in April served at the Siege of Matagorda. In 1812 his health broke down and he was invalided to England. He is the author of several chatty volumes of recollections, which give an excellent idea of the lighter side of military life at the time of the Peninsular War (see *Dictionary of National Biography*, Vol. XXXII., p. 51).

The portrait was presented by Mr. Edward J. Castle, Q.C., formerly an officer of the Corps, and an account of its presentation is given in the *R.E. Journal* of 1st May, 1889, Vol. XIX., p. 113.

General Sir Frederick Chapman, G.C.B. (1815—1893), obtained his first commission in 1835 and retired from the Service in 1881. He

Digitized by Google

was a Captain in the Corps in 1854 at the time of the Crimean War, and at the Battle of the Alma he was serving as senior Engineer officer with the 1st Division, commanded by the Duke of Cambridge. In October he was appointed to the command—as Director—of the British Left Attack. The first artillery position in the first parallel of this attack was always known as "Chapman's Battery."

On the 22nd March, 1855, when Major John William Gordon, Director of the Right Attack, was severely wounded, Chapman became Executive Engineer for the whole siege, under Sir Harry Jones. He served throughout the siege with great distinction, was made a Companion of the Bath, an Officer of the French Legion of Honour, and was awarded the third class of the Turkish Order of the Medjidie.

From 1860 to 1865 he held the position of Deputy Adjutant-General, Royal Engineers. In 1867 he was appointed Governor of Bermuda, and from 1870 to 1875 he was Inspector-General of Fortifications. In 1872 he became a Colonel Commandant of the Corps. He was promoted K.C.B. in 1867 and G.C.B. in 1877, and died in London in 1893.

A biographical memoir by Lieut.-General C. B. Ewart, C.B., occurs in the *R.E. Journal* for 1893, Vol. XXIII., p. 153 (see also *Dictionary of National Biography*, Supplement, Vol. I., p. 413).

An interesting account of Colonel Sir John Underwood Bateman-Champain's services, written by Major-General Sir Robert Murdoch Smith, K.C.M.G., occurs in the *R.E. Journal* for March, 1887. There is also an excellent account of them in the *Biographical Notices of Officers of the Royal (Bengal) Engineers*, by Colonel Sir Edward Thackeray, K.C.B., V.C., and in the *Dictionary of National Biography*, Supplement, Vol. I., p. 139.

Sir John Bateman-Champain (1835—1887) obtained his commission in the Bengal Engineers in 1853. He served with much distinction during the Indian Mutiny at the Sieges of Delhi and Lucknow, and in numerous engagements throughout the period of the Mutiny until its suppression in 1858.

The work however with which his name will always be associated is the construction of the first telegraph line to India through Persia. The officer who was originally placed in charge of this work—Colonel Patrick Stewart, of the Bengal Engineers – died before the completion of the difficult task, and Capt. Champain had the satisfaction of finishing what seemed at one time an almost impossible task. His extraordinary tact and power of persuasion enabled him to overcome the political difficulties in Persia, and his energy and ability for getting the full work out of his subordinates surmounted all the material obstacles.

Digitized by Google

In 1870 Colonel Champain assumed sole charge of the Indo-European Government Telegraph Department. Until shortly before his death, in 1887, he was constantly at work in connection with the Department. Journeys to Russia, Turkey, and Persia, alternated with work on international committees for organizing and regulating the whole system of international telegraphy.

His Knighthood was granted him in 1885 for "Services during many years in connection with the telegraph to India." He had a remarkable personality, and was much beloved by the members of the Indo-European Telegraph Department, by whom his portrait was presented to the Mess.

Major-General Sir John C. Ardagh, K.C.M.G., K.C.I.E., C.B., LL.D. (1840—1907), was commissioned on the 1st April, 1859.

In the winter of 1861, in consequence of the seizure of the Confederate envoys, Messrs. Mason and Slidell, on board the British steamer *Trent* by Capt. Wilkes, commanding the United States frigate *San Jacinto*, a British force amounting to about 10,000 men was despatched to Canada. The weather in the Atlantic during that winter was exceptionally stormy, and many of the hired transports were unable to face it. One of these transports, the *Victoria*, conveying the 96th Regiment and a detachment of Sappers, under the command of Lieut. Ardagh, after putting back once, nearly foundered on the second attempt, and was only kept afloat by the exertions of the troops.

The following is an extract from a letter from the officer commanding the 96th Regiment to the Quartermaster-General, dated on board steam transport *Victoria*, Plymouth Sound, 12th March, 1862 :—

I would beg leave also to call attention to the valuable assistance rendered by Lieut. Ardagh, of the Royal Engineers, and the men of the detachment under his command, in repairing and cleaning the pumps as they became unserviceable and in performing the necessary work about the ship.

The following memo. by the Quartermaster-General conveyed the approval of the Duke of Cambridge to the D.A.G., Royal Engineers :—

The enclosed extract from a report made by Colonel Scovell, commanding the 96th Regiment and the troops on board the *Victoria*, steamer, who re-embarked on board that vessel at Cork for Canada on the 13th ultimo and put into Plymouth on the 12th instant with leaky condition of vessel and disabled engines, in consequence of having experienced severe weather, is transmitted for the information of the Deputy Adjutant-General of the Royal Engineers.

"His Royal Highness was much gratified to hear of the valuable assistance rendered by Lieut. Ardagh, of the Royal Engineers, and the men under his command whilst encountering difficulties and dangers of

Digitized by Google

no ordinary kind, and it is requested that His Royal Highness's approbation of their praiseworthy exertions may be conveyed to Lieut. Ardagh, R.E., and the men of the Corps under his command."

(Sd.) P. G. HERBERT,
*Quartermaster-General.*

HORSE GUARDS, S.W.,
*March 20th*, 1862.

This Order was read out on parade at Chatham—a high distinction for a subaltern of three years' service.

The distinction gained by Ardagh at this early stage in his service was maintained throughout his career. In 1868 he was nominated Secretary of a Committee appointed to inspect and report on the fortifications in course of construction under the Defence Act of 1860. After the issue of the report of the Committee, he received the thanks of the Secretary of State for the satisfactory manner in which he had performed his duties.

In 1873 and 1874 he was at the Staff College, and on completing his course he was sent to the War Office for duty in the Intelligence Department. For the next eight years he was constantly employed in important diplomatic and intelligence work in connection with the politics of the Near East. He was awarded a C.B. in 1878 for his services at the Congress of Berlin, which he attended as a subordinate of Sir Lintorn Simmons, who was acting in the capacity of technical military adviser to Lord Beaconsfield.

For a few months in the early part of 1882 he acted as Instructor in Tactics at the S.M.E.; but the Egyptian crisis of that year required his presence near the centre of disturbance, and in July he was engaged in placing Alexandria in a state of defence against the troops of Arabi Pasha, and in September he was present at the Battle of Tel-el-Kebir.

In 1884 and 1885 he was employed, under Sir G. Graham and Sir F. Stephenson, in the Suakim and Nile Campaigns. In 1886 he was employed in connection with the settlement of the financial arrangements between England and Egypt. For his services in this connection he received the thanks of the Treasury. In 1887 he was appointed Assistant Adjutant-General at the War Office for Defence and Mobilization.

In 1888 he became Aide-de-Camp to the Duke of Cambridge, and later on in the same year he was selected by the Marquess of Lansdowne, the Governor-General of India, for the post of Private Secretary. This position he held until Lord Lansdowne completed the term of his Vice-Royalty in 1893. In the following year he was appointed K.C.I.E.

In 1895 he was appointed Commandant of the School of Military Engineering, and in the following year he was selected for the

Digitized by Google

important position of Director of Military Intelligence at the War Office.

On the 18th February, 1896, he was married to Susan, widow of the third Earl of Malmesbury, by whom the portrait now hanging in the Mess was presented to the Corps.

He held the appointment of Director of Military Intelligence for five years, years of incessant and arduous work, more especially as they included the period of the South African War. At one time there was an idea that the British Government had not been sufficiently informed as to the state of preparation for war of the Boer Republic, and this notion, if correct, would have implied blame to the Intelligence Department. But the publication, first by American newspapers, and then by the *Standard*, of the contents of "Military Notes on the Dutch Republics of South Africa"—a secret work compiled by the Intelligence Department, a copy of which had fallen into Boer hands after the action of Talana—and the evidence given before the Royal Commission on the War in South Africa, proved conclusively that Ardagh had carried out his duties in the most thorough manner. He had, indeed, in spite of a very limited staff and inadequate funds, kept the authorities at the War Office fully informed both as to the condition of affairs in South Africa, and the military resources of the Boers, and also as to the number of troops necessary for the defence of the Colonies. These he estimated at 40,000, while the force requisite for carrying war into the enemy's territory he fixed at 200,000, as has been made public in the *Times*. After the printing of the "Military Notes" by the *Standard*, copies of the original work were, at Ardagh's request, laid upon the table of both Houses of Parliament.*

Ardagh was retired from the Army under the age clause of the Royal Warrant on the 9th August, 1902, but continued to be employed by the Foreign Office, and was nominated in the same year British Member of the Permanent Court of Arbitration at the Hague.

In June, 1906, he was appointed Senior British Plenipotentiary at the Conference for the revision of the Geneva Convention of 1864 "for the amelioration of the condition of wounded in armies in the field." Practically all his proposals are embodied in the new Convention.

He died on the 30th September, 1907.

Colonel Sir Charles Watson and Lieut.-Colonel J. E. Edmonds have written an appreciative memoir of his life in the *R.E. Journal* for November, 1907. The memoir closes with the following words:—"There are but few officers of the Royal Engineers who have had so interesting a career as Ardagh, or who have done better service for the State; but the constant calls upon his services for special work

* *R.E. Journal*, November, 1907, p. 304.

Digitized by Google

gave him little time for rest, and the uninterrupted strain somewhat affected his health. Ardagh has shown an example of self-restraint and devotion to duty which may be of help to others in times of trial. Infinite patience, whether in the performance of his work or as regards the shortcomings of others, was one of his most marked characteristics, while his absolute straightness and simplicity of nature gained him the love of all who were intimately acquainted with him. A man of great general knowledge and of varied experience, he thought deeply before he spoke or wrote, and had rarely occasion to alter what he had said or written. In every respect Ardagh has shown throughout his life a bright example of what a Royal Engineer officer should strive to be."

Digitized by Google

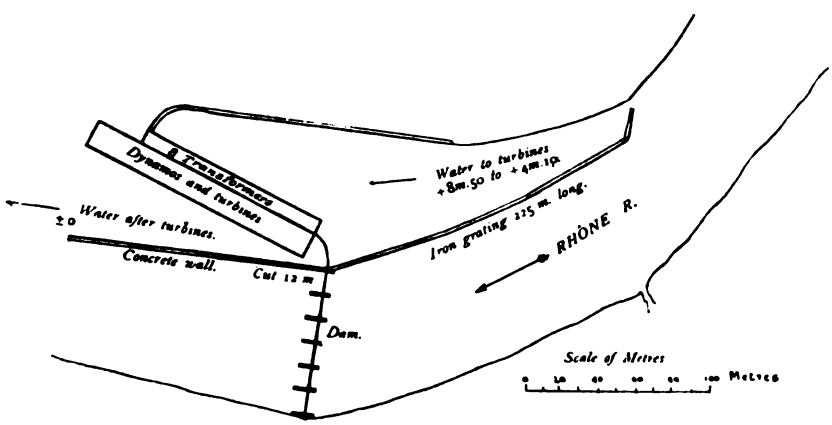
# *TRANSCRIPTS.*

## THE ELECTRICAL SUPPLY OF GENEVA.

From *Notes et croquis techniques sur Genève.*

THE river Rhône supplies the town of Geneva with both water and electricity, and it is proposed in this article to describe the latter installation, viz., that of Chèvres.

The accompanying sketch shows how the buildings are disposed and also how a head of water is obtained.




The fall varies from 8m.50 in winter to 4m.50 in summer. The dam built across the river serves to obtain the necessary head. It consists of seven concrete columns 17 mètres long, 3 mètres thick, and 9m.50 above the river bed. Each of them is further raised 5 mètres for a length of 4m.50, to carry a bridge from which the water gates in the intervening spaces are handled. The river bed is covered with concrete to a depth of 1 mètre between the piles, and is covered by beams 10 centimètres thick, protected by metal. The lower part of the piles is likewise armoured with metal plates 3 centimètres thick, to protect them against wear by the impact of stones, etc., when the water is high.

The actual dam, between the piles is composed of water gates 8·50 mètres high and 10 mètres thick, reinforced by nine powerful parabolic rafters as they may have to support a maximum pressure of 360,000 kilo-

Digitized by Google

grammes. To facilitate the handling of these gates, which weigh 50,000 kilogrammes each, they are made to slide on roller bearings and are moreover each counterbalanced by two boxes full of scrap-iron, which allows of their being raised or lowered with the greatest ease by two men. This system is due to an English engineer, Mr. Stoney.

The water escaping over the dam is separated from that issuing out of the turbines, by means of a concrete wall 130 mètres long, 4 mètres high, and 2 mètres thick at its base. It was found at first that a difference in level of 60 centimètres existed between these two streams of water, and accordingly a cut, 12 mètres broad, was made in the wall, to bring them to the same level and increase the head of water. The suction caused by the water escaping through this narrow opening actually draws in through the cut more water than would be absorbed by the mere difference in level, and—by thus causing an additional increase in head—has raised the power of the turbines by 800-h.p. when the river is very full.

The water enters the turbines by a canal 120 mètres long and 40 mètres broad, which however gradually gets narrower. The bed of this canal is of concrete. A grating, with bars 9 mètres long and inclined at 45° to the horizontal, prevents any logs, or other materials floating on the river, from entering the canal and blocking it up. This grating is 225 mètres long and rests with one end on the right bank of the river. It is supported on a wall 2 mètres above the river bed, whose foundations in some places are as deep as 5·70 mètres below the bed.

Piles are driven into the river above the grating to direct heavy floating bodies away from it towards the dam, over which they can escape.

The building containing the dynamos is 137 mètres long and 12·50 broad. It contains 15 alternators, which have an average horse-power of 1,000, *i.e.*, varying from 1,200 in winter to 800 in summer, and four continuous current machines of 150-h.p., worked by three turbines, serve as exciters to the alternators.

Owing to the great variation in the height of the fall (8·50 mètres to 4m.30) a special type of turbine was necessary. Two turbines and the alternator are on the same vertical shaft. The speed of the turbines depends upon the height of the fall, and the diameter of the dynamo depends upon its angular velocity, the problem being therefore to use the same dynamo with a varying head of water. This is solved as follows:—

In winter, when the waters are high, only the lower turbine works. It is divided into three superimposed wheels of different radii and gives an efficiency of 75 per cent. with a head of 8m.10, the power being 1,200-h.p.

In summer the head falls to 4m.30 and the power of the lower turbine is reduced to 400-h.p. The water is consequently allowed to work the upper turbine, whose power is 400-h.p., and only differs in construction from the lower one in diameter and by its apex angle. A total horse-power of 800 is thus obtained.

The 15 alternators produce a two-phase current (of 47 cycles per second) at a voltage of 2,750. The four continuous current exciters consist of three dynamos giving 750 amperes at 115 volts, and one dynamo giving 1,000 amperes at 115 volts.

Digitized by Google

The switchboard is divided into three parts :—

(1). For the exciters.
(2). For the alternators which feed the underground network at 2,750 volts.
(3). For the overhead network at 5,500 volts, provided by eight transformers, which are directly connected to some of the alternators.

A loss of 10 per cent. is allowed for, and the voltage at the end of the lines is taken as 2,500 and 5,000 volts.

The energy produced is distributed in two networks :—

(1). The underground at 2,750 volts.
(2). The aerial at 5,500 volts.

The latter can in case of need be used to help the former, as it is joined to it.

The underground network of the town and its surroundings is 6 kilomètres long, and at every kilomètre a transformer is installed to supply the local requirements.

Electricity is supplied by this system to private houses :—

(1). By means of a three-wire single-phase network at 2 × 120 volts.
(2). By means of a three-wire two-phase network at 550 volts.

This latter supplies the arc lamps of the town with 550 volts at 40 amperes, a transformer being situated in the pedestal of each arc lamp.

The aerial network feeds :—

(*a*). Some chemical works near Chèvres with a 2,750-volt supply.
(*b*). The main lines for the distribution of electricity with 5,500 volts.

One of these lines is joined to an auxiliary steam-generating station, which is used to supplement the Chèvres installation when the waters are low.

Four transformers of 400 kilowatts are situated in this generating station.

Their primaries at 5,000 volts are fed by the aerial network, and their secondaries at 2,500 volts by the underground one, and thus either system can reinforce the other. Another line supplies electricity 14 kilomètres away, whilst a third, 7½ kilomètres long, feeds a chemical factory at La Plaine.

The whole length of the aerial network is 47 kilomètres, that of the underground 58, that of the secondary lines at 120 and 550 volts, 125 kilomètres.

In July, 1906, electricity was supplied to :—

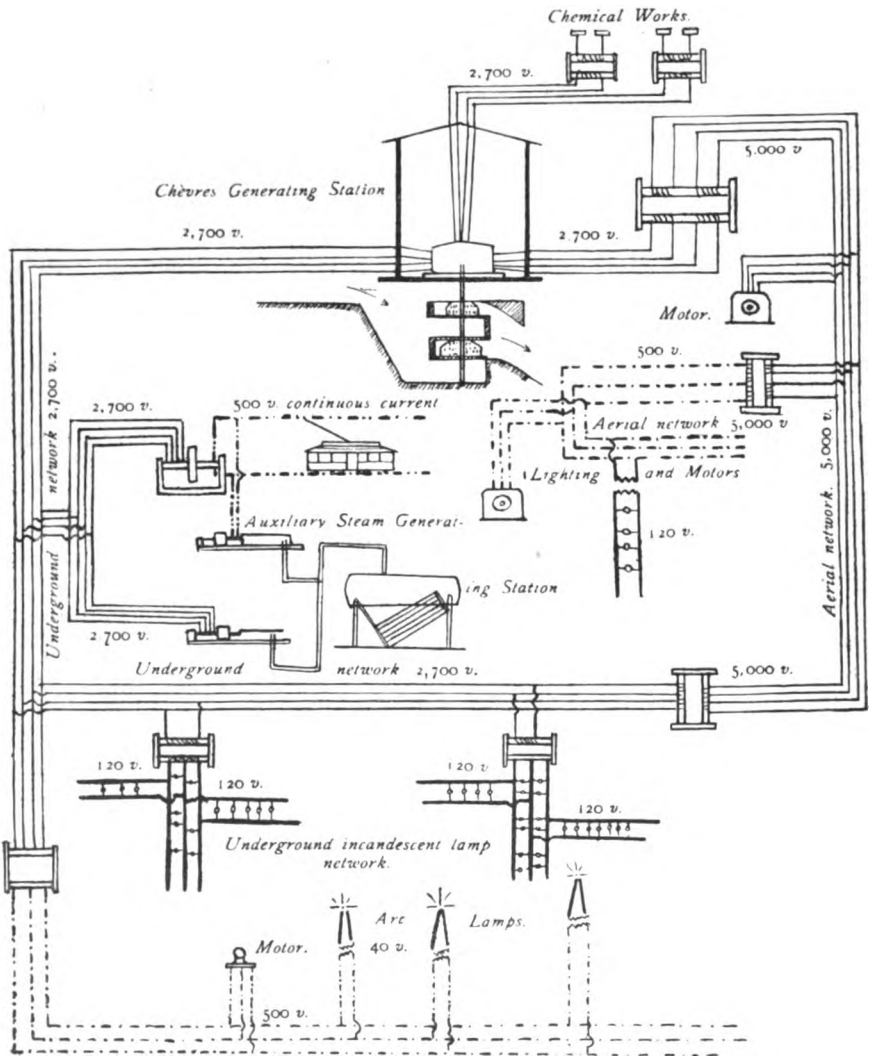
137,200 incandescent lamps (of about 50 watts each).
352 arc lamps for street lighting.
449 private arc lamps.
123 motors of a total of 62-h.p., fed by the 120-volt line.
228 motors (1,363-h.p.), fed by the 550-volt line.
31 motors (6,985-h.p.), fed by the high-tension line.
880 transformers (total 8,000-h.p.) on the various lines.

Digitized by Google

The building of this installation cost the town of Geneva 10,000,000 francs, but the sale of electricity brings in, together with the water supply, 1,630,000 francs annually to the town and constitutes a large share of its annual income.

A. H. SCOTT.

## DISTRIBUTION OF ELECTRICITY IN GENEVA.




*Underground network for motors and street lighting.*

Digitized by Google

# THE PROTECTION OF THE RAILWAY IN TRANS-AMUR.

From the *Voënnyi Sbórnik.*

The war with Japan was waged at a distance of some 10,000 versts from European Russia, the only available line of communication being the Siberian Railway and the newly constructed Eastern Chinese Railway. The inhabitants of the country through which the latter passed, favoured the Japanese cause, but nevertheless throughout the campaign the line was preserved intact. The troops employed for its protection were those of the Trans-Amur Frontier Guard; they were in part the original body recruited for the defence of the Chinese Railway whilst it was being constructed in 1897—1901. Many men and officers eager for a life of adventure and enterprise joined this force from different parts of Russia.

The Trans-Amur military district was organized in a fashion adapted to the object of its existence. The fundamental unit was a detachment consisting of the three arms—usually 3—5 companies, 3—5 sotnyas, and a horse mountain battery. The strength of each detachment varied in accordance with the importance and extent of the portion of railway guarded by it.

The commander of a detachment was a staff officer with the powers of a regimental commander, and he was responsible for the security of his section of the railway, including all structures and telegraphs. He had two field officers as assistants, and another who acted as staff officer for the whole of the artillery for administrative and supply purposes. For discipline three detachments were united under one brigade commander, who had the powers of a divisional commander. He was assisted by an officer of the general staff and by a field officer whose duties were administrative. The officer commanding the whole district had the powers of the commander of an independent army corps; he was however later in the war subordinated to the commander-in-chief in Manchuria.

The normal establishment of the Trans-Amur Frontier Guard appears to have been 55 companies, 55 sotnyas, and 7½ batteries, divided into 12 detachments and 4 brigades, the strongest of which consisted of 18 companies, 18 sotnyas, and 3 batteries. This brigade protected a most important extension of the line, namely, Harbin to Kai-yu-an and the river Sungari from Harbin to the Amur.

The infantry and cavalry were both armed with carbines, and the latter in addition had also swords and, in some cases, lances. The guns were 77 and 57-mm. and fired fixed ammunition. The troops were increased in number on several occasions during the war.

There was a naval department in the district during the war for

Digitized by Google

controlling the steamers and for managing the guardships stationed at barriers on the large rivers.

The Eastern Chinese Railway cuts both Manchuria and the western part of Mongolia in half; from the frontier to Harbin the line traverses the vast salt plains of Mongolia, pierces the Khingan ridge, and emerges on to the desert flats. The most important structures on this section are the Khingan tunnel and the Nonni Bridge. The line from Harbin to Vladivostók lies in very sparsely populated and intersected country; the largest works in connection with it are the Mudadzyan Bridge and the group of Daimoi tunnels. From Harbin to Tiehling the line traverses the Manchurian plain, and thence to Tashihchiao follows the valley of the Liao. The southern branches pass through the richest part of Manchuria. There are two large bridges over the Sungari, and numerous smaller ones, such as those over the Chingho, Hunho, etc. In the northern part of Manchuria the inhabitants were favourable to the Russians, but in the south they were hostile.

The headquarters of the 12 detachments were fixed at places of some importance, such as the Nonni Bridge. The length of line guarded by each detachment was divided into sections for the mounted and dismounted men concurrently; the one did not as a rule coincide with the other. To the more important works, such as bridges and tunnels, special garrisons were allotted and officers were detailed as their commandants.

A dismounted section of the line was divided into sub-sections of about 5 versts in length, guarded by pickets housed in temporary defensible barracks built alongside the permanent way, and 4 to 5½ versts apart. Close observation of the railway and telegraph was carried out by patrols.

The mounted sections furnished 5 to 30 horsemen to the commandants of important works; the remainder were kept at stations and intermediate posts within the limits of the section, as standing pickets which sent out mounted patrols usually at night time along the railway, and twice a week into the country on both sides of the line.

At the outbreak of war, the means existing for the defence of bridges and other buildings appear to have been meagre. The garrisons at bridges were, in summer, accommodated in tents, and in winter were provided with mud huts. Barracks at the stations, and temporary barracks at intermediate posts, had been completed, but the majority of the former were used as hospitals and the garrisons quartered in mud huts. The boundary walls only of the temporary barracks were bullet-proof. They were made of brick and had two small bastions at opposite corners for flanking fire. Loopholes at first were badly made, being at a convenient height for an opponent, but later on they were improved.

At the middle of the campaign, the defences at the Khingan tunnel took the form of two bullet-proof walls for artillery and rifle fire above the entrance and exit, and of two temporary bullet-proof buildings holding 50—60 men each. At either end of the tunnel, on a level with the track, was a wooden blockhouse to hold 8—10 men.

Digitized by Google

At the large bridges, such as those over the Nonni and Sungari and other navigable rivers, booms were constructed with guardships moored near them.

Towards the middle of the campaign the defensibility of bridges was much increased by the addition of obstacles, such as wire entanglements, wolf pits, and pointed stakes, which were usually made to a width of 28′ to 35′. In winter, ditches in the ice with wire entanglements in front of them were constructed along the bridges, and besides this each pier had its own ditch and entanglement. For firing along the river beds, rough parapets on the decking of the bridges were made with sandbags.

Projectors were rigged up to illuminate the booms in connection with the defences of the four largest bridges. In the case of smaller bridges a line of kerosene lamps was placed on the ice. All garrisons at bridges and other posts were connected by telegraph and telephone, and were well provided with rockets and signalling apparatus.

An official work entitled "Regulations for the Preservation and Defence of the Eastern Chinese Railway" was issued, and contained detailed instructions to provide for every possible contingency. A handbook writen in simpler language was used by the lower ranks.

Much attention was paid to the *morale* of the Trans-Amur troops, whose spirit appears to have been excellent in spite of the trying circumstances in which they worked. They were always well provided with food and clothing. A special paper called the *Trans-Amur Leisure Hour* was published, and three local papers were sent regularly to the officers. Spiritual needs were not disregarded; a church coach was continually travelling up and down the line.

The defence of the line was not entirely passive; small bodies of troops were concentrated at various places, and made expeditions as occasions offered.

About the time of the retreat after Liaoyang, the number of troops guarding the line was much increased and averaged 10 men per verst for the whole line, and 21 men per verst for the southern branch (*i.e.*, Harbin southwards). After Mukden a further increase was made, and the average then was 22 men per verst for the whole line, and 39 men per verst for the southern branch.

Numerous instances are given of the work of the troops in guarding the line and of attacks on bridges successfully repulsed.

A. H. Bell.

Digitized by Google

# *NOTICES OF MAGAZINES.*

## JOURNAL DES SCIENCES MILITAIRES.

*November 1st*, 1908.

Under the title of "Automobilism from a Military Point of View," this number contains suggestions as to employment of motors in the future. Their use by generals and their staffs, with motor-cyclist escorts, is considered certain. Despatches will be carried by motor cyclists instead of cavalry. Infantry carried in motor wagons will be able to rapidly reinforce threatened points; engineers can be brought to their work, such as bridge building, without the fatigue of marching; raiding parties will be able to get at the enemy's line of communications much more easily by moving rapidly round his flank.

A short account of the German machine-gun regulations follows. The organization is in 13 six-gun batteries. Each battery is divided into three sections, each under an officer. As a general rule machine guns are not to be employed singly.

The Japanese infantry tactics are illustrated by an extract from a report on the 6th Division. Close communication is maintained between infantry and artillery, and there is no firing till the infantry reach decisive range. They then dig a small trench and open a heavy fire. An assault is to be expected in most cases. Obstacles are destroyed by night. Cold steel only is used in night attacks.

*November 15th*, 1908.

"Automobilism from a Military Point of View" is continued. The replacement of horsed wagons by motor vehicles is suggested for cavalry transport. Much reconnaissance duty might be done by motor cars, possibly armoured and carrying machine guns. Such cars could also be used to increase the fire power of cavalry. A short history of armoured motor cars follows. Modes of employment include the removal of wounded from the battlefield, and, in exceptional cases, the replenishment of ammunition there. The suggestion is made that by using a motor a general could personally examine the state of affairs in battle without exposing himself unjustifiably. Short descriptions of several types conclude the article.

There are two articles on the Manchurian War, and the Russian generalship comes in for severe criticism. The commanders anchored

Digitized by Google

themselves to positions; the officers were not sufficiently educated; the artillery buried itself in its works to such an extent that it could not open fire when targets appeared at unexpected points. The great lesson of the war is the importance of training men in hand-to-hand fighting. The second article deals with infantry tactics—the Japanese tactics seeming to be very similar to our own.

The Swiss use the Maxim type of machine. With the cavalry it is carried on pack horses, and used from a tripod carriage. One eight-gun battery is attached to each cavalry brigade, and there is a suggestion of using these guns with the infantry also. A special carriage enables the gun to be fired by a man lying down, and experiments are being made with an equipment to enable a man to carry the gun on his back. The use of machine guns in recent wars has not been quite satisfactory, and our methods in South Africa are adversely criticized.

In the December number of the *Journal* there is nothing of special interest to sappers. Opinions on the reorganization of the artillery and infantry have been collected from a large number of officers, and the following are some of the ideas suggested:—(1). The brigade is an obsolete organization. Divisions of four 4-battalion regiments should be formed under a general and an assistant general. (2). All infantry in France should have the same 3-battalion organization. There should be no special fortress regiments. (3). Several suggestions are made to reorganize the whole army on the system of every unit containing three of the next smaller unit. (4). The present arrangements for war, adopted in 1875, should be replaced by a system which does not assume defeats at the outset as unavoidable. (5). Good officers cannot be had without good pay. On the frontier an extra allowance should be given. (6). Engineers should be organized in 2-battalion groups. One battalion should be with the field army and the other should feed the reserve formations. (7). A table is given showing the percentage of colonels in each arm. The number of generals are proportionate to the number of colonels—Infantry, 1·45 per cent.; cavalry, 2·75 per cent.; artillery, 2·15 per cent; engineers, 3·5 per cent. (8). A 6-gun battery divided into two sections of three guns each is proposed. (9). Experiments on the power of pom-poms for piercing gun shields are called for.

In an article on the "Decisive Attack" the instructions contained in the official regulations are enlarged upon. These instructions are rather vague. The aim of the decisive attack is to seize a position defended by the enemy and follow up this success until victory ensues. Stress is laid upon the necessity of acquiring a fire superiority, which is considered to have been obtained when, from any cause, only a small portion of the enemy's firearms remain fit for use. The close co-operation of artillery with the infantry is absolutely essential. It is desirable that the artillery should obtain an advantage before the infantry gets to decisive range.

Some extracts from the diary of a French captain in the Morocco campaign follow. They give a good idea of the experience of an eye-witness at Casablanca.

H. L. Woodhouse.

Digitized by Google

## NATURE.

*November*, 1908.

WINDMILLS AND WATER-WHEELS (*p.* 4).—Natural sources of power are discussed in a volume by R. S. Ball. The author uses the word "natural," to describe those sources of power which provide us directly with mechanical energy without any intermediate transformation, such as combustion or the like; and the two particular supplies of energy to which attention is directed are wind power and water power. It is rather surprising to be told that the demand for windmills was never so great as it is to-day, or the trade of the manufacturer of such motors never so brisk. On the other hand, evidences of the utilization of the water powers of the world are everywhere abundant, the chief agent in this being the development of electrical technology.

Chapter I. deals with general principles, such as the distinction between "power" and "energy," efficiency of machines, units, etc. Chapter II. is concerned with water power and modes of measuring. The fundamental theorem of Bernouilli, which says that the sum of the pressure head, the velocity head and the height above datum level is constant at all points in a pipe running full of water, is discussed, as are also weirs, etc.

Subsequent chapters deal with the different kinds of water-wheels and hydraulic turbines, their general design, theory, and regulation. Descriptions of several typical installations, working under such widely different conditions as heads of 2′ and of 2,000′, are given. The modern, or "American," windmill forms the subject of the last two chapters. Constructional details are given, as well as particulars of tests on the power developed and the cost thereof when applied to different industrial purposes. The book can be specially recommended to those readers who, while not being specialists in the particular branch dealt with, desire to obtain a general survey of the subject.

SOLAR VORTICES AND THEIR MAGNETIC EFFECTS (*p.* 20).—It has been found that when a sunspot is near the middle of the solar disc, the direction of the light, from the spot, is along lines of force which are at right angles to the plane of the vortices in which the electric currents are encircling. If now the sunspot be on the limb of the sun, the light from the spot is along the lines of force, or in the plane of the circulating electric currents. The observations of both these longitudinal and transversal effects indicate conclusively that sunspots are very intense magnetic fields—a most important discovery.

CAISSON DISEASE (*p.* 40).—Men who have been working in compressed air either under water in diving dresses or diving bells, in caissons used in preparing foundations for bridges, etc., or in making shafts or tunnels through watery ground, are liable to a variety of symptoms known as "caisson disease." These symptoms, which come on only at, or shortly after, the return to atmospheric pressure, vary in severity, from pain in the muscles and joints to paralysis and even death. These attacks are

Digitized by Google

due to the fact that air (chiefly nitrogen) which has been dissolved in the fluids and tissues of the body while under-pressure, may on decompression be liberated in the form of bubbles, which produce local or general blocking of the circulation or other injuries. If decompression is effected slowly, the mass of air which had been taken up could escape by diffusion through the lungs, and thus bubbling could be avoided. The phenomenon is, in fact, that of decompressing soda water by pushing in the stopper; the problem of the prevention of caisson disease, is how to push it in so slowly that the gas can escape without forming bubbles, and without the loss of so much time that the primary object of the manœuvre is frustrated. The duration of the exposure to high pressure is of the utmost importance. The rate of decompression must be adjusted to the height of the pressure and the duration of exposure; what is safe after one hour at 60 lbs. pressure would be waste of time if the pressure had been 30 lbs., or the time of the exposure only 10 minutes.

THE ECLIPSE OF JANUARY, 1908 (*p.* 70).—An expedition from the Lick Observatory went to Flint Island in the Southern Pacific, to observe the total eclipse of the sun of January 3rd. This island is in latitude 11° S., and is 450 miles N.W. of Tahiti. The weather on the morning of the eclipse was extremely sensational, rain falling in torrents between five minutes before and three seconds after the commencement of totality, but happily the clouds dispersed and the remainder of the eclipse was observed in a comparatively clear sky.

In the intra-Mercurial planet research two sets of cameras were employed, each set so arranged as to include an area 9° broad and 28° long in the direction of the sun's equator. Three hundred star images, going down to the 9th magnitude, were recorded. And all have been identified. It now seems certain that no planet brighter than the 7th magnitude exists nearer the sun than Mercury.

Observations on the Corona show that in all probability its brightness is mainly due to reflected ordinary sunlight, diluted to some extent by the emissions from incandescent particles, and possibly also by some small amount of "luminiscence," such as produces the Aurora.

THE SURVEY OF AFRICA (*p.* 103).—The whole history of this geodetic work is a curious inversion of the general order. Usually it is the complaint of the map-maker that, whereas it is not difficult to get money from the Government for the immediate practical work of mapping, it is a more laborious task to persuade them of the necessity for a liberal expenditure upon the fundamental geodetic triangulation. In South Africa the exact reverse of this has been the case, and we have the anomalous position of a complete triangulation system without the resulting maps. Even now it is only in the case of the Orange River Colony, and partially in Cape Colony, that any of the maps of the country are based upon the geodetic points.

The base measurements have been carried out with "invar" wires hanging freely, at a constant tension, between low tripod supports. Five bases, totalling a length of 70 miles, were measured. Each was

Digitized by Google

gone over with the wire three times, and the apparent probable error with an inexperienced staff was only 1 in 7,000,000. Sir D. Gill maintains that with a trained staff a base can be measured in this way with an actual error of less than 1 in 1,000,000, or about 1″ in 15 miles. The rate of progress averaged 475 yards per day, and the cost was about £153 per mile of base. The horizontal angles were observed with the 10″ Repsoll theodolite, the probable error of a single angle being found to be only 0″·30 with eight changes of zero.

W. E. WARRAND.

---

## NEUE MILITÄRISCHE BLÄTTER.

ARMY AND SPORT.—In the issues of 9th and 23rd November, 1908, Hauptmann v. Scheibert discusses the value of sport for the soldier. He points out that the Japanese possess all the good qualities required in a soldier, "enthusiastic courage and tenacious bravery, utter disregard of death and thoughtful circumspection, steadfastness in bearing great exertions, true discipline and unconditional confidence in his leader, combined with the greatest power of initiative." Only a portion of these qualities are the inheritance of this race, but even these are strengthened and increased by the peculiar education of the Japanese nation. The Japanese of the middle and upper classes grow up accustomed to the use of arms—champions at feats of arms being regarded as national celebrities. Sporting exercise such as football, athletic sports, and gymnastics is practised everywhere. The training is directed to cultivating coolness and self-control. Added to this the Japanese are thorough monarchists and loyal to the 2,000-year-old dynasty of their rulers. The parting word, as the son left home for the war, was never "Come back safe and sound," but "Die for our country." Though almost every family in Japan must have suffered the loss of some near relatives during the late war, their grief was never seen outside the closest family circle, whereas the failure of any military undertaking was at once noticed throughout the country. All these qualities and self-reliance are to be obtained by cultivating sport.

The writer of the article quotes General v. Blume's "Foundations of Our Defensive Power," in which military exercises for schoolboys are described as useless if they are not—as in the upper classes of cadet corps and in the N.C. officer preparatory schools—conducted in all earnestness, and with the same thoroughness as in the army, but modified with consideration for the physical development of the youth. "Vain is the idea that the proper military training of the man can be facilitated by playing at soldiers when a boy. It effects no useful purpose, but still it flatters the vanity of youth and awakes in it a ready conception of military duty." When the period of service arrives the absolutely necessary drill effects its object, but, unless supplemented by gymnastics, camps, and

Digitized by Google

individual combats, is to a certain extent injurious to the soldier's liveliness of mind, quick perception, and utilization of surprise situations, capacity for independent decision, in fact to just those qualities which appear desirable and attainable by games and sport. It is thus far more important for the education of the youth before entry into the army to form these moral qualities, as well as to develop his physique, than to occupy him with a "dead" military drill which does more harm than good. . . . "Leave all playing at soldiers quietly on one side, except a few necessary march movements, forming fours, etc., in order to be able to march decently to and from the playing field."

The effort is repeatedly made to revive German games. They are played keenly for a half-hour, but do not rouse the enthusiasm that football and cricket do. While German games are forsaken as wearisome when the gymnastic lessons are over, these English games have so much power of attraction that they are played with pleasure and keen interest long past the gymnastic lessons, not only by youths but by grown men. The writer therefore urges the importance of these games, together with German and Swedish gymnastics and swimming. The English system of schoolboy camps is recommended, as also are tours through the country, not so much for the purpose of learning how to pitch a tent or to cook, but much rather in order to learn how to do without things, to work for each other, the joy of service, and strengthening of patriotic self-reliance, "of which we Germans are just so sorely in need."

The writer concludes by saying that a youth brought up on these lines without playing at soldiers, but with a strong body and a fresh spirit, will produce splendid material for the army, a firm framework for the mass of modern armies, which is continually growing flabbier. This invigorating "skeleton" to an army is a powerful factor for victory. The first Napoleon would never have been able to conduct his campaigns of 1813, 1814, and 1815 in the way he did with the rapidly-raised recruits had not his numerous veterans given bone to that flesh and enabled the army to accomplish such extraordinary efforts. The proper training of the manhood of a nation is the first step towards victory.

It is interesting, in this connection, to consider this German opinion with reference to the new scheme of preliminary training in the Officers' Training Corps for our reserve of officers for the Regular Army. According to the German view it would appear that the ordinary school training of our public school boy leaves nothing to be desired in providing the framework on which to build the officer, while military training proper cannot usefully be commenced until the cadet joins the senior division of the Officers' Training Corps at the university.

The German view however contemplates the standard attained by the very thorough training of the German officer. Though we may aim at this standard in the case of the special reserve officers, it does not seem possible to expect it from officers of the Territorial Force, and it is therefore more especially for these that the senior division of the Officers' Training Corps at universities would appear to be fitted if we are to accept the German argument, which, further, confines the utility of the instruction in the junior division of the Officers' Training Corps at public

Digitized by Google

schools to inculcating the groundwork of a military spirit. It may also be supposed that the exclusion of "dead" military drill from the instruction of the boy, as advocated by the Germans, does not preclude instruction in signalling and musketry, both of which it would seem possible with advantage to teach to the public school boy. Signalling, when learnt young, is less easily forgotten, while experience with enlisted boys has already proved that trouble taken with them over musketry instruction is well repaid.

E. G. WACE.

---

## REVUE DE L'ARMÉE BELGE.

*July—August*, 1908.

The *rôle* of sappers is discussed in this number of the magazine. How much should the sappers do in the construction of fieldworks in war, and how much should be left to the infantry? The Belgian Regulations, it is pointed out, are very vague on this subject, with the natural result that sappers are falsely employed in one of the three following ways:—(*a*), Either they are made to construct works which should have been made by the infantry; or (*b*), they are used as supplementary infantry and their technical training not made use of; or (*c*), they are completely forgotten.

To remedy this state of affairs it is suggested that the following principles should be inserted in the Field Service Manuals:—

(1). The divisional engineers should be employed in the construction of works which are intended to improve the general situation of the division, such as important demolitions, obstructions, and the improvement of communications.

(2). When on the defensive, the trenches should be made by the troops destined to occupy them, aided by a few sappers when redoubts or magazines have to be constructed.

(3). The commander of a company of sappers should never be told in detail how to subdivide his command; he is the best judge in this matter, and can tell off his company, once he has seen the various tasks to be carried out.

(4). Both in attack and defence, the divisional C.R.E. should take part in the preliminary reconnaissance of the position.

(5). The divisional C.R.E. should not be also the commander of the divisional company of engineers, as the latter is too busy with arranging the work of his company to be able to grasp the situation thoroughly and decide what the company must do.

The proportion of engineers in the Belgian Army is 1 sapper company, 267 strong, per division of 18,096 foot soldiers, *i.e.*, 1·5 sappers per 100 infantry. This does not include technical troops, such as telegraphists, balloonists, etc.

Digitized by Google

A telescopic spade, designed by Lieuts. Brouyère and Spaak, is also described. As a result of the Russo-Japanese War it has been decided that each Belgian soldier shall carry an entrenching tool, two-thirds being shovels, and one-third axes, saws, and pickaxes. This shovel, which has a telescopic handle 60 cm. long when closed and 1 mètre when pulled out, claims the following advantages over the usual implement carried by continental troops :—

(1). Perfect solidity—being made of steel. Its weight is 1,100 grammes.

(2). A great diminution in fatigue owing to the length of the handle (1 mètre) when opened out.

(3). A considerable increase in efficiency, for the same reason.

(4). Saving of time.

(5). It can be used for field kitchens, as two spades, with the mess tins hung from them and a fire underneath, form an ideal field kitchen.

The most recent organization of the Dutch Army is given, and is as follows :—

(1). *Headquarters*, of which the details are secret.

(2). *Field Army*.—Headquarters ; 4 divisions and 1 cavalry brigade ; 1 division is composed of 1 squadron hussars ; 1 company cyclists; 3 infantry regiments, *i.e.*, 15 battalions or 60 companies; 1 field artillery regiment, *i.e.*, 2 groups equalling 6 batteries or 36 guns ; 1 infantry ammunition column and 1 artillery ditto ; 1 company pioneers ; 1 telegraphic section ; 1 bridging section ; 1 section of transport and supply troops ; 1 section medical troops.

In case of war, the war minister can raise a cavalry brigade consisting of :—

4 regiments cavalry = 12 squadrons ;
2 batteries horse artillery ;
1 cavalry and 1 artillery ammunition column.

If the cavalry brigade is not raised, a cavalry regiment of 4 squadrons is placed at the disposal of each infantry division.

In peace time an infantry regiment has only 4 battalions, in war time 6, of which the 5th joins the field army and the 6th the fortress troops. Each field artillery regiment also has a reserve battery, which is at the disposal of the war minister.

The following troops are also attached to the army headquarters :—

1 section railway troops ;
1 telegraphic section ;
1 pontoon section ;
1 brigade sanitary troops.

Digitized by Google

(3). *Fortress Troops.—i.e.*, Headquarters.

12 infantry battalions = 48 companies;
3 regiments fortress artillery = 30 companies;
1 regiment coast artillery = 10 companies;
1 corps of cupola artillery = 4 companies;
1 corps of torpedo troops = 2 companies;
4 companies sappers;
Telegraphic units and medical troops;
23 "landweer" battalions of 4 companies each;
44 "landweer" fortress artillery companies;
4 "landweer" engineer companies.

(4). *Troops for Territorial Defence.—*

25 "landweer" infantry battalions;
4 batteries reserve field artillery;
The colonial reserve.

(5). *Depôt Troops of the Regular Army.—*

12 depôt battalions infantry = 48 companies;
2 depôts of hussars;
4 depôts of field artillery;
4 battalions of depôt fortress artillery = 16 companies;
1 depôt of pontoonists;
1 engineer depôt;
1 depôt of administrative troops.

The cavalry and engineer depôt troops are alone existent in peace time; the other depôts merely have a staff of officers and N.C.O.'s.

The strength of the various units is as follows:—

1 division = 18,800 men, 2,500 horses, 560 vehicles;
1 cavalry brigade = 2,500 men, 2,570 horses, 150 vehicles;
*i.e.*, Field army = 78,000 men, 13,000 horses, 2,450 vehicles;
Fortress troops = 68,000 men and 70 horses;
Territorial troops = 31,000 men, 1,320 horses, and 370 vehicles;
Depôt troops = 1,200 men, 36 horses;
Grand total = 180,000 men, 14,500 horses, 2,800 vehicles.
And on war footing, 1 battalion = 1,050 men and 21 officers;
1 squadron = 5 officers and 150 men;
1 battery = 6 guns;
1 field company sappers = 3 officers and 170 men.

There are also interesting articles on the following subjects:—The Russo-Japanese War; the Greco-Turkish War of 1897; the *rôle* of cavalry in war—with special reference to Napoleonic cavalry; the military education of young officers; trial of armour and cupolas; the Defence Committee of Holland.

A. H. SCOTT.

Digitized by Google

## Revue du Génie Militaire.

*November*, 1908.

The Central Battery Telephone System.—This system has been in use for some years in England, America, Belgium, Italy, etc., but is only now being introduced into France. The author describes two separate installations which are used with a central battery. He also gives the details of a third installation, which he considers would be suitable for a military telephone exchange.

The Fourth Arm in Conjunction with the Others.—The author gives a short historical review of the way in which field fortification has been used in the Franco-Prussian War, American Civil War, and the Russo-Japanese War. He points out that it has been successfully employed by both defender and attacker for the purpose of economizing men, and thereby increasing the number available for either a turning movement or a counter-attack. In the event of another Franco-German war the line of the frontier—200 kilomètres—would correspond approximately to the length of front of the forces engaged. He therefore suggests that the frontier zone should be prepared and organized as a single defensive position.

The Maintenance of Gas and Water Mains.—An account of a method of locating leaks in gas and water mains. The pipes are divided into short sections by valves. In each section there are one or more taps, to which a pressure gauge may be fitted. Leaks are tested for by closing the valve at each end of a section and noting the pace at which the pressure falls. A rapid fall indicates a serious leak in the section.

J. E. E. Craster.

---

## Revue Militaire des Armées Étrangères.

*November*, 1908.

An article, on the use of "skis" in warfare, is given in this magazine. "Skis" and "Canadian racquets" are indispensable in winter for progress in hilly countries, and the following is a general comparison of the advantages of each. A Canadian racquet is of insignificant cost, requires little care, is easily attached to the boot, and allows the soldier to carry the regimental haversack. Moreover, no special training is required to teach its use, and 20 men with racquets before a column will open out a road for the remainder to walk on in boots.

The ski is very expensive, requires constant care, is very difficult to fasten to the boot; the ski-er cannot carry a haversack and leaves practically no trace on the snow. Moreover, it can only be used by

Digitized by Google

specially trained men, who cannot march close together. The maximum speed available however is 10 kilomètres per hour, as against 7 to 8 per hour with a racquet.

The tactical uses of these two forms of locomotion are as follows:—

(1). A small number of ski-men will act as scouts and orderlies, marching independently of the other troops, and acting as cavalry.

(2). A larger number of troops on racquets will be in the advanced guard for closer reconnaissance, and to open up the road for the troops behind, who will not be supplied with them. France, Germany, Russia, Sweden, Norway, Austro-Hungary, Switzerland, and the United States, all train troops in the use of the ski.

In Norway ski-ing is learnt whilst at school. In winter but few troops are under arms, and consequently little is done of a military nature, but the Sports Union organizes races which are semi-official. There are two companies of cyclist-ski-men who use either means of locomotion, according to the time of the year.

In Sweden, as in Norway, much is carried out by sports clubs, but men in the infantry are also trained in the winter, *i.e.*, all officers (30 per regiment), 20 N.C.O.'s, and about 240 men per regiment.

In Russia ski training is much used and regular competitions officially organized in each military district. In the St. Petersburg district four men per company are regularly trained, as are also four to eight men per squadron, or sotnia, of cavalry. There are no official instructions as to the course, which is organized by officers regimentally.—(*To be continued*).

The review of the new *Felddienstordnung, 1908*, and the study of the Russo-Japanese War are continued.

In Austria a volunteer corps of motorists and motor cyclists has been recently raised. To belong to this "Motor-Korps," recruits must be Austrian or Hungarian citizens, possess a motor of at least 16-h.p., and a driving license. They get 15 crowns per diem for peace training and 1,000 crowns (£40) indemnity on the outbreak of war. Their preliminary training consists of three periods of 10 days per annum for four years. The motor cyclists must also be Austro-Hungarian citizens and possess a motor cycle of at least 5-h.p., or a small car of 8—14-h.p., or a light motor cycle of 1½-h.p. Their pay is 15 crowns per diem for small cars or six per diem for a motor cycle. War indemnity, 1,000 or 300 crowns, according to vehicle. They are organized by groups in military divisions. Both corps wear a grey uniform with yellow boots and gaiters, and carry a revolver and field glasses.

A light grey uniform has recently been adopted by the Austrian Army, a distinctive feature of which is that the officers' uniform is just like that of the men, with the badges of rank on the collar.

A grey-green uniform has also been adopted by the German infantry and experimentally by the cavalry.

A. H. SCOTT.

Digitized by Google

## Rivista di Artiglieria e Genio.

*September*, 1908.

New Regulations for Pioneers in Austria-Hungary.—*L'Armeeblatt* of the 3rd September has an article on the reorganization of the pioneers in the Austro-Hungarian Army. According to the new regulations the pioneer troops will consist of 15 battalions, numbered progressively 1 to 15. Each battalion in peace time consists of five companies, of detachments for a complementary company, and of an office for material (*Zeugreserve*). In addition No. 1 Battalion has detachments of submarine miners and pontoniers.

The pioneer battalions provide detachments at the disposal of the director of military works, and also for isolated services at the various establishments.

The battalions stationed in garrisons have their 5th company permanently detached, either in the forts or in their vicinity. The pioneers are instructed in the following technical services:—

(*a*). *For all the Companies.*—The construction of such works of field fortification as require the use of special tools; the construction and destruction of roads and works of communication of every kind; railway construction and the destruction of railways and bridges; all works relating to the employment of explosives; technical works of greater importance, which may be required for an army in the field, either in camp, in cantonments, or on the march.

(*b*). *For the First Four Companies of each Battalion.*—Construction of military bridges; works required for the attack of fortified places.

(*c*). *For the 5th Company of each Battalion.*—Works relating to the attack and defence of fortified places, especially with regard to obstacles, works of approach, and mines; the placing in a state of defence of fortified places; construction of military bridges to a limited extent.

The submarine and pontooning detachments receive special instruction according to their denominations.

A captain to each battalion is posted for special employment. He assists the commander of the battalion generally, and is also charged with the following details, viz.:—Giving instruction in the official schools of the corps and attending the collective instruction of the officers and cadets of the battalion; directing the school for non-commissioned officers; assuming the command of a company which for any reason may have been deprived of its title for more than four weeks. The captain for special employment ought not to remain in this position for more than two years, during which time he should take part in the exercises of the troops, whether military or technical.

The equipment of the pioneers consists of the infantry sword for the officers, for the cadets doing duty as officers, and for the quartermasters; repeating rifles (M. 95) with sword bayonet for all the men in the fighting line; revolvers (M. 07) for the officers, and cadets doing duty as officers, for the medical officers, and for all the non-commissioned officers armed with the infantry sword; the pioneer sword for the non-

Digitized by Google

commissioned officer of stores, for the armourer, and for men detached on special service in peace times.

The organization of the pioneer troops is as follows :—

(1). For the first four companies of each battalion: 5 officers, 107 men.
(2). For the 5th company of each battalion : 5 officers, 104 men.
(3). For the office of stores : 1 officer, 9 men.
(4). For the complementary company: 2 officers, 7 men.
(5). For the detachment of submarine miners taken from the 1st Battalion: 1 officer, 28 men.
(6). For the pontoon detachments taken from the 1st Battalion : 5 officers, 105 men.

The complete strength of a battalion in peace time is 33 officers, 550 N.C.O.'s and men, and 11 horses. To provide the detachments of troops under the military works department the battalions also allot 32 N.C.O.'s and 110 pioneers. The pioneers allotted for special employment are distributed to the following offices :—War minister ; inspectors-general of engineers and pioneers; inspectors of pioneers at Vienna, Graz, Linz, Budapest, and Cracovia; special military technical courses; military technical committee; camp at Bruck; military schools of instruction, etc.

The organization of the 15 pioneer battalions consists of 2 colonels, 5 lieut.-colonels, 8 majors, 85 captains of the 1st class, 36 captains of the 2nd class, 183 lieutenants, 152 sub-lieutenants, 30 cadets doing duty as officers. The superior officers, the captains, and the adjutant-major are mounted.

The inspector-general of pioneers—in addition to inspections—is entrusted with the direction of all the technical administrative service relating to the pioneers, the cadets' school, and the pioneers' parks. He is the consulting officer of the Minister of War, and gives advice on all questions relating to the pioneer services, their organization and technical instruction.

The inspector-general of pioneers cannot issue orders which would be contrary to the regulations ; he can only repress errors or abuses which would be detrimental to the service and which he observes during his inspections. He especially assists at the more important technical exercises of the pioneers. He refers to the War Minister all questions relating to the promotion, transfer, and personal changes of the officers and cadets of the pioneer battalions.

At Vienna, Linz, Graz, Cracovia, and Budapest five inspectors of pioneers are stationed. Each of these inspectors has three pioneer battalions ; at Vienna the inspector also has charge of the park. The companies detached from their battalions are inspected by the inspector of the district in which they are stationed.

In communications relating to the service the inspectors should not in any case constitute themselves as an intermediary organ between the superior officers and the pioneer battalions. It is their particular duty to exercise an intense influence on the instruction of the officers and cadets, and on the economic distribution and expenditure of war material.

Digitized by Google

Reorganization of Gunpowder and Explosive Services in France.—A decree dated 26th June established a new order for the services of explosives (*gunpowder and saltpetres*). All the establishments for gunpowder and explosive services are placed under the immediate direction of the Minister of War; their technical direction is entrusted to the corps of *engineers for powder and saltpetres*, assisted by a permanent *personnel* of *technical agents for powder and saltpetres*. The powder manufactory at Bouchet alone remains under the direction of artillery officers.

The inspectors-general are charged with the permanent inspection and surveillance, and have access to the minister charged with administration.

The inspectors-general present to the said minister all the proposals and requirements relating to the *personnel*, the machinery, and the maintenance of the establishments under them. They compile every year a report on the general working of each establishment.

In the case of a fire or an explosion, the inspector-general is called by telegraph and proceeds to the spot and institutes an enquiry.

Each establishment has a chief director, who corresponds directly with the minister. He is entrusted with the direction of the works, the *personnel*, the administration, and the supply of material. He is also responsible for all matters which concern the sanitary services of the establishment.

There are also engineers, pupil engineers, and technical agents who direct, and are responsible for, the several works. They arrange for the placing of the material in the magazines of the establishment, being careful to return any surplus; they have the disciplinary surveillance of the workmen, and are not allowed to make any alterations in the works entrusted to them without the sanction of the director.

The service of the establishments is administered by a *council of administration*, which is composed of the director as president, the managers as members, and a special agent who performs the duties of secretary, but has no vote. The council makes and verifies the contracts in writing, and controls the payments and proposals for new expenditure. The duties of accountants are performed by special agents who have completed at least 15 years' service in the establishment. A technical agent performs the duties of accountant of stores, and is specially charged with the duties of registration, consignment, and consumption of material.

All the services relating to the powder and explosives establishments are under the surveillance of the corps of administrative control of the army, according to the law of 16th March, 1882. An impending ministerial regulation will determine the rules for service in the establishments.

*October*, 1908.

Influence of Dirigible Balloons on the Art of War.—The following extracts are taken from an article published in the *Internationale Revue* (Supplement 112), and deal with the services which dirigible balloons may render to the commander-in-chief in war time.

Digitized by Google

"War," says Clausewitz, "is the region of the uncertain." Three-fourths of the actions on which war is based are always found in a mist of uncertainty more or less great. And, indeed, the experience of war teaches that the issue of events is nearly always different to that which at first we are able to foresee. In any case, those who can make their dispositions so as to surprise the enemy have much in their favour.

Now, it may be asked, if the art of war may not be modified, and if, to use the words of Clausewitz, the clouds may not be dispersed by the use of dirigibles. Under the modern conditions of the industry, the dirigible balloons, with systems rigid and semi-rigid, are able to make voyages of several hours, and, under favourable conditions, are able to explore distant regions.

While the dirigibles still require to be much improved, it is certain that in a few years they will be provided with more powerful mechanism, and at the commencement of hostilities they will pass the frontier to observe the massing of the enemy's armies, and by means of visual signalling or by wireless telegraphy will transmit notices of the results of their observations. The long columns of troops and of wagons which traverse the great high roads, the trains which pass rapidly along the lines of railway, the crowds on the bridges, and the concentration of great masses of troops, will none of them be able to escape the observation of the occupants of the car.

Firearms will not be a sufficient guarantee against this kind of exploration. The balloon is difficult to hit because it travels rapidly and changes its altitude in a few minutes. Neither rifle bullets nor shrapnel can cause very serious damage; the small holes made in the balloon by such projectiles cause only such a slight escape of gas as not to diminish the ascent to any serious extent. The chances of the balloon being struck by artillery projectiles, other than shrapnel, are so slight that they need scarcely be considered.

It must not be thought that this new means of exploration will render the task of the officer in command any easier, or that he should rely on the intelligence derived therefrom to an extent which would weaken his efforts. Now that the commanding officer cannot hope to surprise his adversary he should be prepared, with greater care and with a wider view, for any eventualities which may present themselves. Any error will be all the more serious because the enemy will not be ignorant of what has happened. Any omission on the part of the chief in command, any error of an officer of lower grade, will be known in sufficient time to enable his adversary to derive profit therefrom. War will no longer be a game of cards, but will rather resemble a game of chess—with this exception, that the number and value of the pieces will differ.

The same argument is discussed in the periodical *Vierteljahrshefte für Truppenführung und Heereskunde*, in which the General, von Blume, expresses his views that dirigibles will play a very important part in future wars, especially as regards observation. It may happen that the first lines may not be perceptible, but this will not be the case with the reserves, and the knowledge of their positions is of primary importance,

Digitized by Google

because of the possibility of deducing therefrom the time, etc., of their intervention. These important masses of troops cannot escape the observations of the balloons, which will be able to communicate the results either directly, or by wireless telegraphy.

The General concludes by arguing that such a state of things will confer great advantage on the defensive, since the offensive will be deprived of its ability to surprise, which is one of the principal assets of success.

*La France Militaire* however expresses quite a different opinion, asserting that inventions of this kind, as well as nearly all progress in arms and armaments, are for the advantage of the offensive.

It is not sufficient for an army to be aware of a danger which may be in front of it, and in fact when a dirigible may signal the formation of an important mass of the enemy's troops and the commencement of its movement in a given direction, it may be too late to provide against it.

In order to be prepared at the precise moment, the intentions also of the enemy should be known, so that troops could be set in motion to defeat any object some time before it is on the eve of execution.

It will probably however be easier to organize the offensive owing to the information furnished by the dirigibles about the reserves of the defending troops, whose movements are, of course, dependent upon the intentions of the attacking force. By a simple calculation, the attack may so be able to direct its masses that the enemy may not have the time to reunite and concentrate the force necessary for confronting them.

In conclusion, the advantage seems to be with the offensive, because the dirigible allows of the attack being opened in a direction in which the dangers have been well weighed, and against an adversary who is forced to remain on guard along his entire front.

BULGARIA.—*Distribution of Mitrailleuses.*—*La France Militaire*, of the 17th October, notifies that the 144 Maxim mitrailleuses, ordered in Germany for Bulgaria, were distributed in May last to 36 infantry regiments, in each of which a company with four mitrailleuses has been organized.

A captain and an armourer—who have undergone a special course of three weeks at the arsenal at Sofia—are assigned to each infantry regiment. Besides the above mentioned, a certain number of officers for foreign service have been through special fire courses in Russia or Austria.

Before the end of the year the officers who have attended these courses, and who are intended to take command of a mitrailleuse company, will have instructed their *personnel*, consisting of two non-commissioned officers and four privates taken from each company of a regiment.

The strength of a mitrailleuse company, for two pieces only, will consist in time of peace of 2 officers, 4 non-commissioned officers, 20 men, and 12 horses per company. In war time however the companies will each have four pieces, and will form an integral part of an infantry regiment.

Digitized by Google

GERMANY.—*Automobiles for following Dirigible Balloons.*—The review, *Le Génie Civil*, extracts from the *Practische Maschinen Konstr.* of the 2nd July the following regarding an automobile designed for chasing dirigibles constructed at the *Rheinische Metallwaren und Maschinenfabrik* of Dusseldorf.

This motor, of 50 to 60-h.p., has an average velocity of 45 km. per hour. It has an armoured shield and a revolving quick-firing cannon of 5 cm. on the Ehrhardt system. The carriage, with the cannon, the ammunition, and five men, weighs 3,200 kg.

The cannon throws a grenade and a shrapnel shell, with velocities respectively of 570 and 450 mètres. The shrapnel has a charge of 40 g. and contains 128 bullets; on explosion the shell also gives 27 splinters.

The projectile is furnished with an after-effect mechanism graduated to 4,200 mètres and joined with a system of fins or blades working by centrifugal force, and which are intended to increase the laceration in the envelope of the balloon.

The greatest range is 7,800 mètres, corresponding to an angle of fire of 43°; the greatest ordinary trajectory is 2,500 mètres.

EDWARD T. THACKERAY.

---

VOËNNYI SBÓRNIK.

NOTES ON THE ARTILLERY DEFENCE OF PORT ARTHUR (*continued from February*, 1907).—This article gives a detailed account of the nature and distribution of the guns in Forts I. to III. and intermediate works at Port Arthur.

Some of the remarks made on details of construction may be of interest.

The most serious defect in Fort II. (North Keikwansan), was the fact that the glacis was not commanded by fire from its own guns, nor from guns in any of the neighbouring works. This enabled the Japanese to get a foothold on the glacis during the August assaults, and they stayed there for 1½ months.

An apparatus was devised for throwing mines amongst the Japanese working on the glacis. The projectile was removed from the cartridge of the 47-mm. (1·85″) gun, and in its place a small lead cylinder the exact size of the bore was inserted to act as a gas check; the cartridge was loaded from the breech in the ordinary way. A long staff with a mine fastened to the end of it was then shoved down the muzzle. When the cartridge exploded the lead cylinder drove the staff with the mine attached out of the gun. The greatest range obtainable was about 200 paces. The passage of gas past the lead cylinder sometimes caused the mine to explode prematurely, always with disastrous results.

Digitized by Google

Fort II. had double-storied concrete barracks along the gorge blinded with earth. The arches of the roof were about 3′ thick. Whenever a large shell struck the roof it penetrated about 1′; the remaining 2′ of thickness were shattered and a large slab of concrete, together with the shell, fell onto the floor of the barrack room below. The fuzes of the shells were not sensitive enough to explode on the first shock, but were sufficiently so to go off when the shell landed on the floor.

In one of the numerous intermediate works the magazines were roofed with two rows of 18″ square baulks placed crosswise, with two 1″ iron plates on top of them, and 3′ 6″ of earth over all. This covering was proof against all shells except those from the 11″ howitzers.

In a neighbouring work, the roofs, which were made similarly but without the iron plates and with 1′ 9″ of earth, were pierced by all shells, even those from field guns.

THE EFFICIENCY, FOR DEFENCE, OF FORTRESSES DURING CONSTRUCTION.—This article in the September number of the *Voĕnnyi Sbórnik* is briefly to the following effect:—

The time taken in building a fortress is usually considerable, and is governed to a great extent by the amount which the State is prepared to spend annually on its construction. There is always a possibility of war breaking out before any works of much defensive value have been completed, although much earth may have been turned up.

History gives us many examples to show that half-finished fortifications are better than none at all, *e.g.*, Sebastopol, Viksburg, Belfort, Plevna, and Port Arthur, but it is wrong to suppose that permanent works are no longer a necessity. If a large garrison is required in a permanent work, a larger one still would be wanted in a temporary work intended to fulfil the same object. The losses of troops behind permanent works are always smaller than those of troops in semi-permanent works, whilst the losses in the attack are correspondingly larger. For example, the garrisons of "temporary" Sebastopol and of "semi-permanent" Port Arthur were practically the same—about 40,000 men; the average losses during one month of siege were, in the case of Sebastopol, 9,000 men in the defence and 5,000 men in the attack, and in the case of Port Arthur, 4,000 men in the defence and 20,000 men in the attack. If the defences of Port Arthur had been of a permanent nature the difference would have been still more marked.

The problem is how the defence of a strategical point can be carried out, so that, in the event of war breaking out before it is completed, the works already constructed will be of the greatest possible defensive value. The answer is that the system of construction should be one of successive stages, in accordance with the following conditions:—

(1). At the end of each stage the works should be completely defensible, and answer the tactical and strategical requirements.

(2). The period in which each stage is constructed should be as short as possible.

Digitized by Google

(3). Each portion of a work during construction should be capable of being improved without injuring the efficiency for defence of the whole.

(4). The most important portion of each work should be begun first.

(5). No single work in the main position should be left entirely untouched.

When it has been decided, in connection with any strategical point, which position is the one to be defended and where the works are to be, it remains to determine what portion of each work should be started first.

Four main ideas have to be considered—communications, field of fire, cover, and obstacles. The first two are virtually disposed of when the site for the work is selected. As regards the other two, it is well known that a defender's losses are mostly caused by shell-fire during bombardments, and the existence of bombproof barracks is therefore of primary importance. The losses in Sebastopol per 40 lbs. of shells discharged by the enemy were, before and after the construction of bombproof casemates, as 10 to 2 respectively. The presence of obstacles has the effect of keeping the attacker longer under the fire of the defender, forces the attacker to make special efforts to destroy them, and also acts indirectly in favour of the defender, who, knowing that his obstacles are good, does not expose himself in so great numbers as he otherwise would do, when an assault is being made. In Sebastopol there were enormous losses among the reserves, who had frequently to be kept concentrated at threatened points. Bombardments last as a rule much longer than assaults; good casemates are therefore of much greater importance than obstacles. Besides, there is no better obstacle nowadays than a rapidly developed and overwhelming fire, and this can only be counted on when troops are safely housed till the last possible moment in casemates in close proximity to the parapet. It follows therefore that the first portion of a fort to be constructed should be the bombproof barracks.

This fact has long been recognized in Germany, and is evidenced by the fortifications at Breslau, Marienburg, and Grandenz, which consisted of lines of bombproof barracks for infantry, surrounded, in the last two cases, by simple field parapets.

Russian practice is introducing an essential improvement on the German, in that the casemates are to serve not only as safe dwelling-places in time of war, but as barracks in time of peace.

Simultaneously with the construction of casemates, works of low profile, capable of being developed into something of a more permanent nature, would be thrown up.

In the October number the writer gives an example of a fort, which he has designed, capable of being constructed in three years in several successive stages. The bombproof barracks are first built; they are

Digitized by Google

reckoned to hold 126 men in peace time and 300 in war. At the same time a low field parapet is thrown up round them.

By successive stages the parapet is increased in size, the ditches deepened, caponiers added, etc., until at the end of the third year the fort is complete with counterscarp galleries, tambours, palisades, and countermine galleries.

At the end of each stage in its construction, the fort has been rendered capable of defence in a degree proportional to the time and money spent on it.

A. H. Bell.

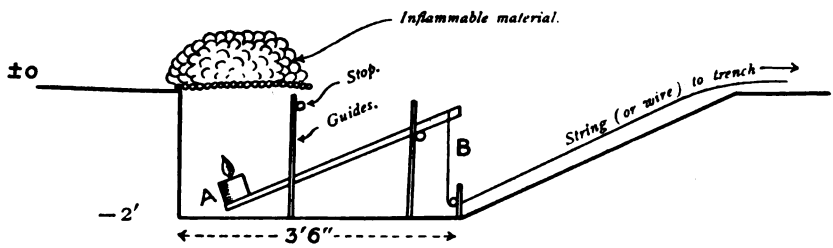
Digitized by Google

# *CORRESPONDENCE.*

## A MECHANICALLY OPERATED FLARE.

DEAR SIR,

Colonel Roper, in his article dealing with the defence of a position at night, referred to the use of mechanically operated flares as an adjunct to obstacles. The following is a brief description of one which was tried in 1907, with perfect success, on the annual fieldworks course of the 21st Company.




A lamp A is fastened to the end of a stick arranged as shown in the diagram. A string B is fastened to the other end of the stick, is brought round a smooth horizontal piece, and thence led away to the fire trench. Inflammable material is laid above, and so arranged that when the string is pulled the flame of the lamp is lifted into the midst of this inflammable material. A jam or tobacco tin makes a first-class lamp, and the whole arrangement comprises nothing which cannot be usually found on the spot. The lamp is lit at dusk and should burn through the night. Nothing can be seen from the front, and there is nothing to get out of order. The details of this flare were explained to me by Major Dobbie, of the Indian Army, who informed me that it had been made by native troops on manœuvres.

Yours faithfully,

W. G. S. DOBBIE,

*Capt., R.E.*

The Editor, *R.E. Journal.*

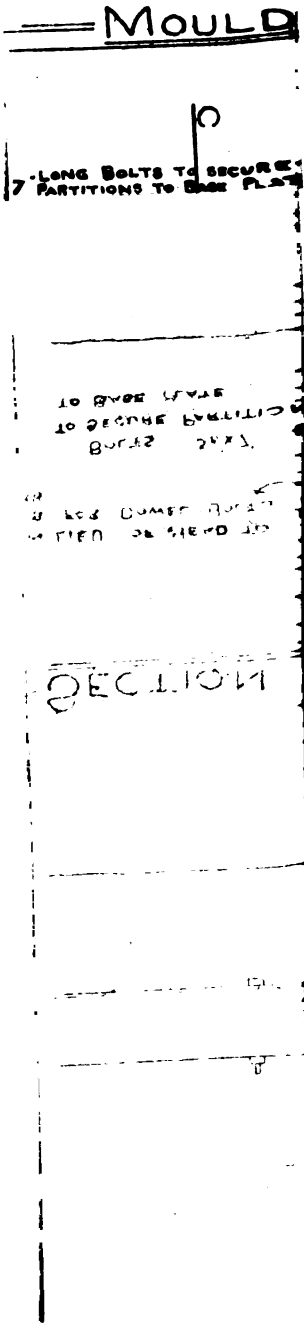
Digitized by Google

Digitized by Google

Digitized by Google

MCS.

PLATE II.




Digitized by Google

Digitized by Google

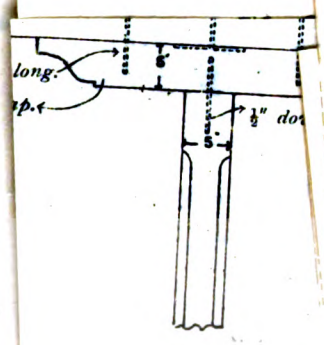
OF

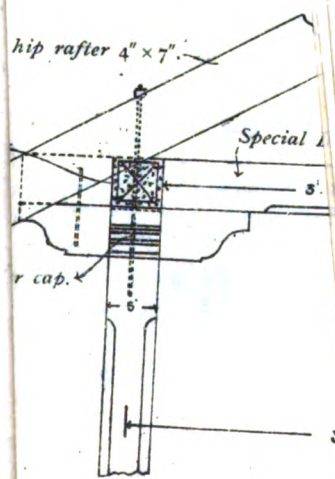
AHME

RRO-CON

*e Elevatio*

*ails— 15"*



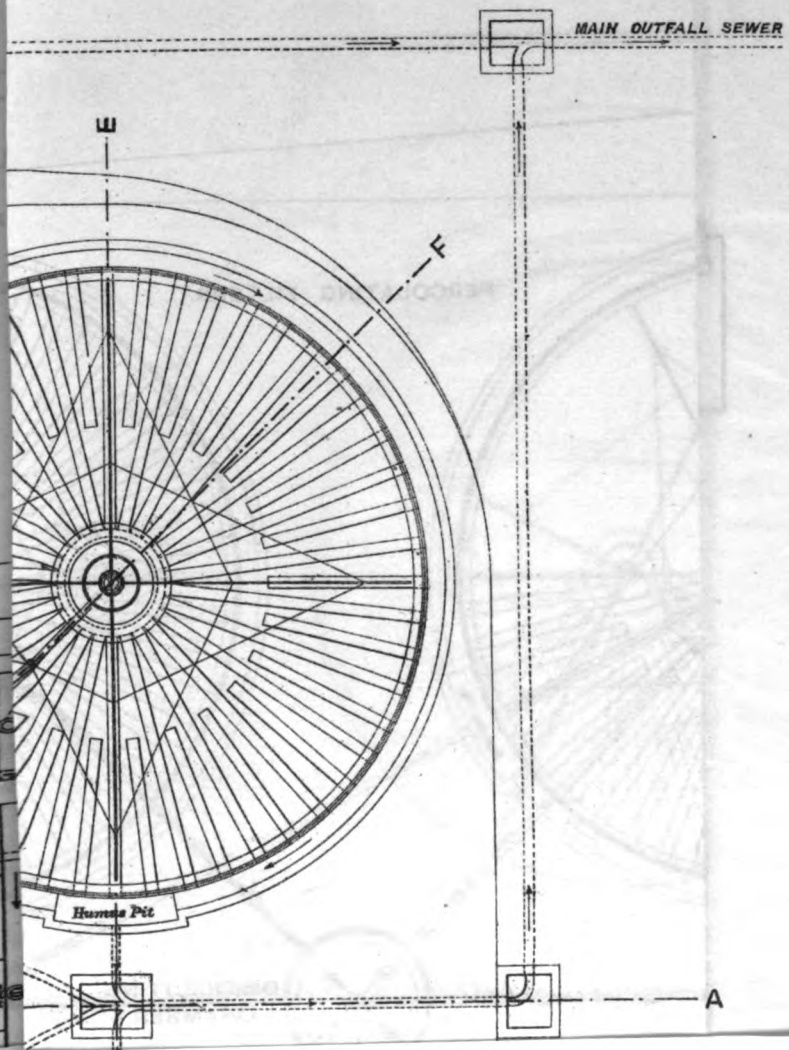

Dowel

Plate 6

Digitized by Google

Digitized by Google

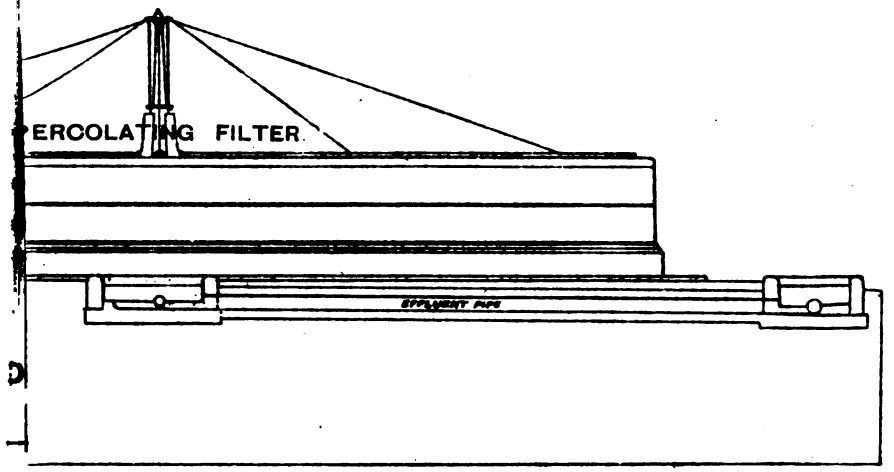
# PLATE I.

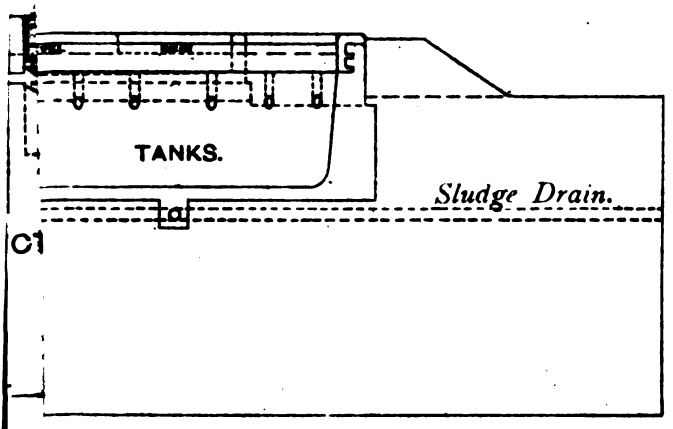



Digitized by Google

Digitized by Google

# PLATE II.



Digitized by Google

Digitized by Google

# THE JOURNAL OF THE ROYAL ARTILLERY.

THIS Journal, which was formerly known as the "Proceedings" of the R.A. Institution, contains articles and information on Artillery matters, some highly technical and some general. Articles on general Military topics also appear.

In the Translations and Précis, which are an important feature, an attempt is made to keep up with the progress of Artillery on the Continent.

All members of the Royal Artillery Institution receive the Journal.

Any officer serving in the Navy, Army, Militia, Imperial Yeomanry, Volunteers and Colonial Permanent Forces can receive this Journal post free on application to the Secretary, R.A. Institution, at an annual subscription of 20s.

**WOOLWICH: ROYAL ARTILLERY INSTITUTION.**

**Agents: DULAU & CO., 37, Soho Square, London, W.**

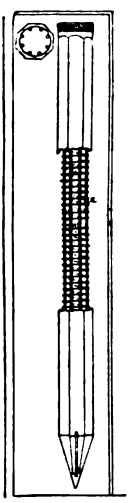
**Single Copies, price 2s. 6d. each, postage extra.**

# THE CONSIDERE SYSTEM

OF

# REINFORCED CONCRETE

IS THE MOST SCIENTIFIC METHOD AT PRESENT IN USE.



**CONSIDERE SPIRALLED ARMOURING** gives a three times greater increase to the compressive strength of concrete than any other system.

It is specially applicable and economical for the construction of PILES, COLUMNS, BRIDGES, and WAREHOUSES.

**CONSIDERE PILES** *can be driven without any cushion or elastic cap of any kind.*

Preliminary designs, with approximate estimates, submitted for consideration free of charge. Complete working details and instructions for work in British Colonies at specially low fees.

For Pamphlet, Illustrations, and further particulars write

**The CONSIDERE CONSTRUCTION Co., Limited,**
**5, Victoria St., Westminster, London, S.W.**


Digitized by Google

# THE HELLIWELL
# PATENT "PERFECTION" GLAZING.

## ADVANTAGES.

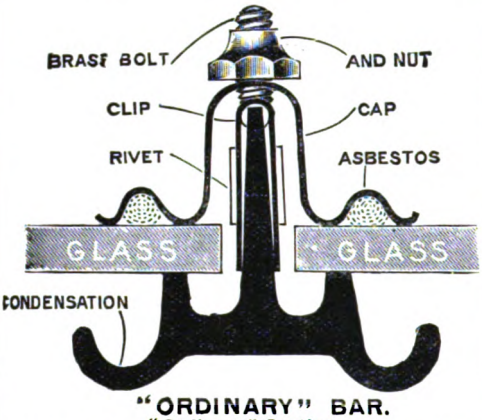
No Puttv.
No Paint.

Guaranteed Water-tight and Dust Proof.

Easily Repaired.

Planks laid in Safety across Caps.

Steel Bars galvanized; and also entirely covered with Lead to prevent Corrosion.




"ORDINARY" BAR.
"Ordinary" Section.
BARS of different strengths, to carry up to 12ft. without Purlin.
CAPS in either Copper, Zinc, or Lead.

## EXTENSIVELY USED BY

H.M. Government, for Barracks, Dock Sheds, Post Offices, Stores, etc.

All the leading Railway Companies.

Municipal Authorities, for Markets, Baths, Libraries, Art Galleries, Schools, etc.

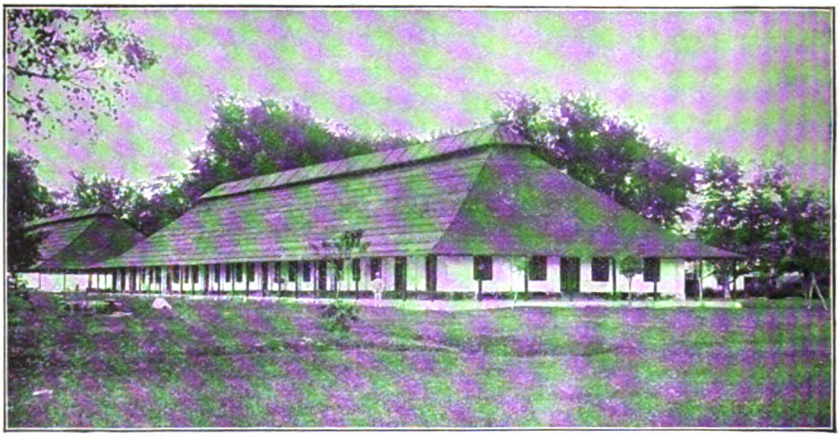
Also for every kind of Glass Roofing

Head Office and Works: **HELLIWELL & CO., Ltd.,**
**BRIGHOUSE, YORKS.**

London Office:
11, Victoria Street, Westminster, S.W.

# RUBEROID!
# ROOFING!

A High Grade Permanent Roofing Material in general use for all classes of Buildings. Its light weight as compared with other roof coverings makes it particularly useful where long transport of building materials is necessary.



Quarters of the Malay States Guides, Sepoy Lines, Penang, covered with Ruberoid.

Full particulars of cost and shipping weights gladly supplied. Our Illustrated Catalogue, No. 39, and samples sent post free on application.

**THE RUBEROID COMPANY, Limited, 81 & 83, Knightrider St., LONDON, E.C.**


Digitized by Google

SPECIFY

# INDENTED STEEL BARS

FOR YOUR

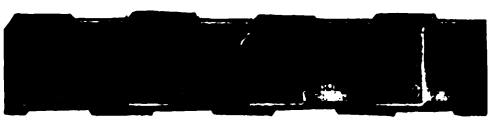
## *Reinforced Concrete Work,*

And you will obtain HIGHEST POSSIBLE STANDARD OF EFFICIENCY, combined with GREATEST POSSIBLE ECONOMY.

**NO ROYALTIES TO PAY.**

Head Office :—

**QUEEN ANNE'S CHAMBERS, LONDON, S.W.**



Branches all over the United Kingdom.

TELEGRAMS :—"PATINBAR, LONDON."

# BENJAMIN EDGINGTON'S

# Tents & Camp Equipment

FOR ALL CLIMATES.

**TENTS.**
**CAMP FURNITURE.**
**CANTEENS.**

**Air and Water-tight Uniform Trunks.**

**DECK CHAIRS.**

**Clothing and Personal Outfit.**

**Double-Roof Ridge Tent,** as supplied for all the principal Surveys, Boundary Commissions, Railways, etc., in East and West Africa, and other parts of the World.

WRITE FOR TRAVELLERS' CATALOGUE.

**BENJAMIN EDGINGTON** (S. W. Silver & Co., and Benjamin Edgington, Ltd.),

**2, Duke Street, London Bridge, London, S.E.**

Telegrams :—"BENJAMIN EDGINGTON, LONDON."

Digitized by Google

## "ANCHOR" LINE.

## Passenger and Cargo Services.

LIVERPOOL to BOMBAY & KARACHI (*viâ* Bombay). Fortnightly.

LIVERPOOL to CALCUTTA. Fortnightly.
**All Vessels call at Egyptian Ports.**

Large New Steamers. Splendid Accommodation for Passengers. Electric Light and Fans.
Excellent Cuisine. Every Comfort.
Moderate Fares, both Single and Return

Apply—"ANCHOR" LINE (Henderson Brothers), Ltd., Liverpool, London, Glasgow, &c.

## Nippon Yusen Kaisha.

Japan direct from London in 47 days, calling at COLOMBO, SINGAPORE and HONG KONG, by fast steamers fortnightly.
KANAGAWA MARU, 6,169 tons, Feb. 6
HAKATA MARU, 6,161 tons, Feb. 20.
**To Japan, £54, 1st Class; £37 10s., 2nd Class; to other Ports at equally moderate rates.**
ROUND THE WORLD, £107.

For Fares, etc., apply at—
**4, LLOYD'S AVENUE,**
**LONDON, E.C.**

## Institution SILLIG,

**BELLERIVE,**
**VEVEY, SWITZERLAND.**

**ESTABLISHED IN 1836.**

A HIGH-CLASS SCHOOL for the education of Boys in Classical, Scientific, Military, and Commercial Subjects, and for General, Moral, Mental, and Physical Development.

PRINCIPAL:
**MAX SILLIG—DE VALLIÈRE.**

## THE ARMY SCHOOL,

**Near MAIDENHEAD**
(Approved by the Army Council).
**Head Master:**
**E. G. A. Beckwith, M.A. Oxon.**
*(Late Exhibitioner of Winchester and Magdalen College).*

"A small public school in which boys from the age of twelve are prepared for the Army. The school buildings include a chapel, large dining hall, swimming bath, gymnasium, chemical and physical laboratories, besides 30 acres of playing ground."

SUCCESSES, 1907—1908.
Woolwich—One.
Sandhurst—Thirteen.
Qualifying Certificates—Sixteen.
Leaving Certificate—Five (Three Woolwich).

For FEES, etc. (reduced for Sons of Officers), apply to the Head Master.

## NOTICE.

## G. E. CARRINGTON,

**53, HIGH STREET, OLD BROMPTON, KENT,**

BEGS to inform his numerous Clients that, owing to the expiration of the lease at 6, CARLTON STREET, REGENT STREET, S.W., he will, after December 25th, 1908, have his London Room for Fitting, etc., at

**Carlton House, Regent Street, Waterloo Place, S.W.,**

and will be in attendance Personally at the latter Address every TUESDAY and THURSDAY, from 11 a.m. to 6 p.m., and at any other time by Appointment.

## HAWKES & CO., LTD.,

TAILORS AND MILITARY OUTFITTERS, CAP AND ACCOUTREMENT MANUFACTURERS,

14, PICCADILLY, LONDON.

*Patronized by many Officers of the Royal Engineers.*


Digitized by Google

SOME PUBLICATIONS BY

# THE ROYAL ENGINEERS INSTITUTE.

| Title and Author. | | Net Price to Non-Members. |
|---|---|---|
| | | s. d. |
| **R.E. Field Service Pocket-Book.** 2nd Edition .....3″ × 5″ | 1902 | 5 0 |
| **The Destruction of Mosquitos,** being an Account of the Drainage and other works carried out with this object during 1902 and 1903 at St. Lucia, West Indies, by Major W. M. Hodder, R.E. ..... | 1904 | 2 6 |
| **Notes for Officers Proceeding to India.** Compiled by Major A. T. Moore, R.E. (Part I. Outfit, Servants, Amusements, Health, Hints for Ladies, etc.; Part II. Physical Features, Administration, Native Army, History, Languages, Castes, Religions, etc.; Appendix. Shooting Hints) ..... | 1904 | 2 6 |
| **Detailed History of the Railways in the South African War, 1899—1902.** 2 vols. (Vol. I. Organisation, Military Control, Working and Repair of Cape and Natal Government Railways; Management, Engineering and other Departments of Imperial Military Railways; Railway Pioneer Regiment; Organisation, Equipment and Use of Armoured Trains; Army Labour Depôts; pp. xli. and 275. Vol. II. 61 Photos and 93 Drawings) .....Folio | 1904 | 42 0 |
| **The Franco-German War, 1870—1871.** Condensed from the German of Major J. Scheibert, and translated by Major J. A. Ferrier, D.S.O., R.E., and Mrs. Ferrier..... | 1894 | 7 6 |
| **The Principles of Structural Design,** by Major G. K. Scott-Moncrieff, R.E., Assoc. Inst. C.E. 2 vols. (663 pp.; 30 Plates and numerous Figures) ..... | 1897 | 10 6 |
| **The Water Supply of Barracks and Cantonments,** by Major G. K. Scott-Moncrieff, R.E., Assoc. Inst. C.E. (311 pp.; 60 Plates and numerous Figures)..... | 1896 | 10 6 |
| **Notes on Blacksmith's Work,** by Major R. F. Sorsbie, R.E. ..... | 1903 | 4 6 |
| **History of the Corps of Royal Engineers,** by Major-Gen. Whitworth Porter, R.E. 2 vols. .....9″ × 5½″ | 1889 | 7 6 |
| **Professional Papers of the Corps of Royal Engineers.** Occasional Papers Series. Vols. I. to XXX., 1877—1904. (Separate Papers at various prices) .....each volume | | 10 6 |
| Fourth Series. Papers 1 to 7, 1905—1907; Papers 1 and 2, 1908. (Royal Octavo, 9″ × 6″). Various prices. | | |

Except where otherwise stated, the books are octavo, measuring 8½″ × 5½″.
They may be obtained from Messrs. W. & J. Mackay & Co., Ltd., Chatham, or from any bookseller.

**All communications concerning Advertisements in this Journal should be addressed to the SECRETARY, R.E. Institute, Chatham.**

**Telegraphic Address - "Sapper, Chatham."**

Digitized by Google

The McKenzie, Holland, &
Westinghouse Power Signal Co., Ltd.

# POWER SIGNALLING

**Electro-pneumatic,**
**all-electric, and**
**automatic signalling.**

**Address:**

**58, VICTORIA STREET, LONDON, S.W.**

Telegrams: "POWERSIG, LONDON." Telephone: 890 Westminster.

**PORTLAND CEMENT.**

# CONCRETE FIRE-PROOF SLABS.

For Internal and External Walls.
As cheap as any other, with the following advantages:—

**ECONOMY OF SPACE, GOOD KEY FOR PLASTER TILING, ETC., NO PLUGGING, AND SETTING COAT OF PLASTER ONLY REQUIRED.**

*For Particulars and Prices apply to:*

**THE ACTON CONCRETE PATENT PARTITION CO., 1909, Ltd.,**

Telegrams: "KONKREET, LONDON."
Telephone: 6294 AVENUE.

**63, CORNHILL, LONDON, E.C.**

# THE OFFICE FOR OFFICERS.

**LIFE ASSURANCE.** Specially designed for the Services.
**CONVENIENTLY PAID FOR** by Bankers' Orders (Monthly Premiums if desired).
**NO MEDICAL EXAMINATION** up to £500, in ordinary circumstances.
**LOANS AND SURRENDER VALUES.** Liberal and easy conditions.
**EXCEPTIONALLY GOOD TERMS** for War Risks and Foreign Residence.

Call or write for new Service Prospectus.

**Royal Exchange Assurance,** (Incorporated 1720.)
**West End Office: 44, PALL MALL, S.W.**

Digitized by Google

# THE ROYAL ENGINEERS JOURNAL.

Vol. IX. No. 3. MARCH, 1909.

## CONTENTS.


| | | Page. |
|---|---|---|
| 1. | **Manufacture and Use of Hand Grenades.** By Lieut. A. L. C. Neame, R.E. ... | 165 |
| 2. | **Recent Progress in Geographical Work.** By Lt.-Col. C. F. Close, C.M.G., R.E. (*With Map*) ... ... ... ... ... ... | 169 |
| 3. | **Railway Signalling.** By Capt. A. Gardiner, R.E. ... ... ... | 181 |
| 4. | **The Preservation of Winchester Cathedral.** By 2nd Lieut. J. M. Smeathman, R.E. (*With Photos*) ... ... ... ... ... ... | 185 |
| 5. | **The Main Underground Telegraph System of Great Britain.** By Major W. A. J. O'Meara, C.M.G., late R.E. ... ... ... ... ... | 191 |
| 6. | **The R.E. Headquarter Mess** (*continued*). By Lt.-Col. B. R. Ward, R.E. ... | 213 |
| 7. | **Transcript:**—The Skerries Wireless Telephone. (From the *P.O. Electrical Engineers Journal* by 2nd Lieut. A. H. Scott, R.E.) ... ... | 217 |
| 8. | **Reviews:**—*Recollections of a Life in the British Army.* By Gen. Sir Richard Harrison, G.C.B., C.M.G., *p.s.c.*, late R.E. ... ... ... | 219 |
| | *Topographical Surveying and Sketching.* By Major T. H. Rees, Corps of Engineers, U.S. Army ... ... ... ... | 221 |
| | *War Songs* ... ... ... ... ... ... | 222 |
| 9. | **Notices of Magazines** ... ... ... ... ... ... | 223 |
| 10. | **Recent Publications of Military Interest** ... ... ... ... | 231 |


CHATHAM:
Royal Engineers Institute.
Agents and Printers: W. & J. Mackay & Co., Ltd.

PRICE: 1s. 6d. POST FREE. ANNUAL SUBSCRIPTION: 15s. PAID IN ADVANCE.

Digitized by Google

THE MODERN ROOFING MATERIAL,

# "ETERNIT."

ROOFING SLATES.

SHEETS FOR WALLS AND CEILINGS.

INDESTRUCTIBLE, LIGHT, ARTISTIC, ECONOMICAL, WEATHERPROOF.

Weight, 22 lbs. Laid.

## G. R. SPEAKER & CO.,

**Engineers & Contractors to H.M. Government,**

**29, MINCING LANE, E.C.**

WIRE—"ETRASHEET." 'PHONE—CENTRAL 13174.

# Norfolk House School,

## BEACONSFIELD, S. BUCKS.

**Special Terms to Sons of R.E. Officers.**

**Prepares Boys from 7 to 14 years of age for Public Schools and the Royal Navy.**

THE School House, recently built, with all the latest improvements, stands 500 feet above sea level, on a gravel soil. It is one mile from Beaconsfield Station, whence there is a good service to London in 35 minutes.

Recent honours gained, include Scholarships,

**MARLBORO' (3), CHARTERHOUSE, FELSTEAD, ALDENHAM, HIGHGATE, AND NAVAL CADETSHIP. . . . . .**

Two £30 Scholarships offered yearly to intelligent boys likely to gain Public School Scholarships or Naval Cadetships.

Prospectus, Names of Scholars, and full particulars from

**Head Master, C. T. MARCON, M.A.**

Digitized by Google

Telegrams—"GUNDRADA, LONDON." Telephone—4716 Gerrard.

THE ARMY, NAVY AND GENERAL ASSURANCE ASSOCIATION, LIMITED

HEAD OFFICE: 217, PICCADILLY (CIRCUS), LONDON, W.

Fire, Theft and Burglary *(Combined)*.

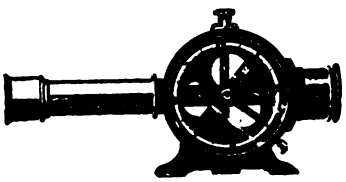
Chargers, Hunters, Marine Risks.

# The "Professional" Policy
. of .
# Accident and Disease Insurance

Is Specially adapted for Military and Naval Officers serving in ANY PART of the WORLD, and now covers 30 Specified Diseases.

**Revised Prospectus of Extended Benefits on application—**

**217, PICCADILLY (CIRCUS), LONDON, W.**



## C. F. CASELLA & CO.,

MAKERS OF

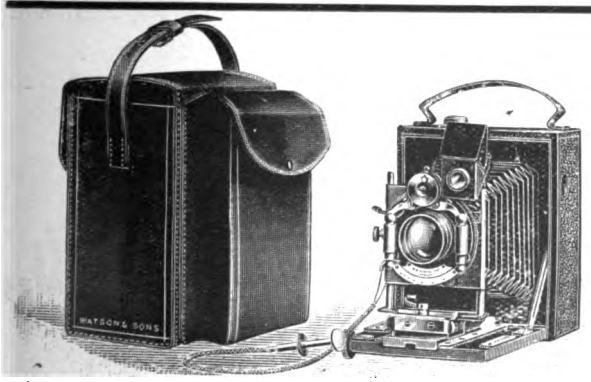
***Surveying & Scientific Instruments***

To the Admiralty, Ordnance and all Home Departments, and to the Indian, Colonial and Foreign Governments.

The Illustrations depict CASELLA'S ALTAZIMUTH, a convenient instrument for rough survey work of all kinds.

WRITE FOR PRICE LISTS.

**11-15, ROCHESTER ROW,**
Victoria St., **LONDON, S.W.**



THE
**'EMPIRE' HAND CAMERA.**

A folding Camera, of best workmanship, designed and made specially for use in the tropics.

QUARTER PLATE SIZE ONLY.

Outfit includes:—Camera, 3 Double Slides, f6 Holostigmat Lens, Diaphragm Shutter, Iso Screen and Leather Case.

**£12 12s. 0d.**

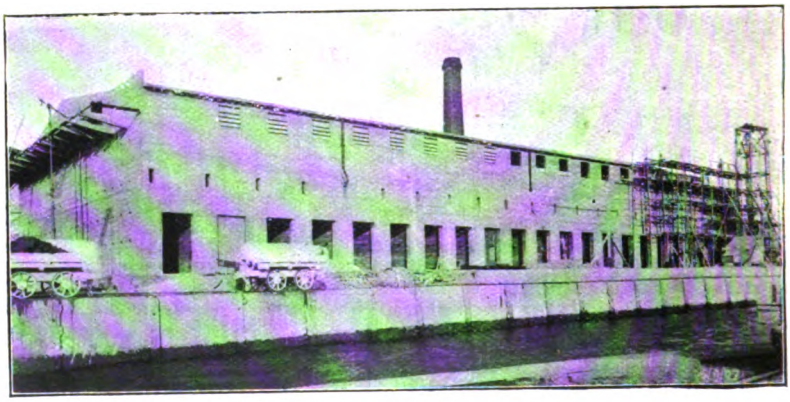
*Write for Photo Catalogue.*

**W. WATSON & SONS,**
Limited,
**313, High Holborn,**
**LONDON.**

Digitized by Google

# EXPANDED METAL

## SYSTEM OF
## REINFORCED CONCRETE
## AND
## FIRE-RESISTING CONSTRUCTION.



EXPANDED STEEL CONCRETE CEMENT STORE FOR THE WOULDHAM CEMENT CO., LTD., WORKS, WEST THURROCK.

### Specialities:—

**CONCRETE REINFORCEMENT**; 3-in. mesh weights Expanded Steel for Foundations, Walls, Floors, Roofs, Bridges, Reservoirs, Sewers, Conduits, Hoppers, Silos, etc.

**LATHING FOR PLASTER**; Expanded Metal Lathing for Ceilings, Partitions, Exterior Walls, Steel Work Encasing, etc.

**MADE-UP GOODS**; Openwork Partitions, Fencing, Clothes and Tool Lockers, Machinery and Tree Guards, etc.

*Full particulars on application to :—*

## THE EXPANDED METAL CO., LTD.,

### YORK MANSION, YORK ST., WESTMINSTER, S.W.

**Telegrams:—"DISTEND, LONDON."** **Telephones:—819 Gerrard; 1514 Victoria.**


Digitized by Google

# PATENT VULCANITE ROOFING

FOR

FLAT ROOFS, CONCRETE ROOFS
AND WOOD ROOFS.

## ROOF TANKS

FOR

SWIMMING-BATHS, RESERVOIRS, BRIDGES.

**EFFICIENT AND ECONOMICAL.**

**For Waterproofing Existing Faulty Concrete and Asphalte Roofs.**

Will give with the movements of the building due to settlement, vibration, and expansion and contraction, and is guaranteed for long periods.

Special surfaces can be provided to the Vulcanite covering to meet any special requirements.

*Full particulars on application to:—*

**VULCANITE, LIMITED, 118, Cannon St., London, E.C.**
**Laganvale, Belfast, and at MANCHESTER.**

(Also Manufacturers of VULCANITE and BITUMEN Sheetings for the Sloping Roofs of Light Buildings, and for use as a Damp-proof Course).

# BULLIVANT & CO., Ltd.,

Manufacturers of

# *STEEL WIRE ROPES*

FOR

CRANES, LIFTS, HOISTS, SUSPENSION BRIDGES, HAULING, Etc.

**DURABLE AND RELIABLE.**

Contractors for . . . .

## AËRIAL ROPEWAYS

Specially designed for conveying Stores, Munitions, etc., across Rivers, Ravines, etc. Can be quickly and easily erected and dismantled. Suitable also for conveying Passengers.

**BLOCKS, PULLEYS, TACKLE, AND ALL WIRE ROPE APPLIANCES.**

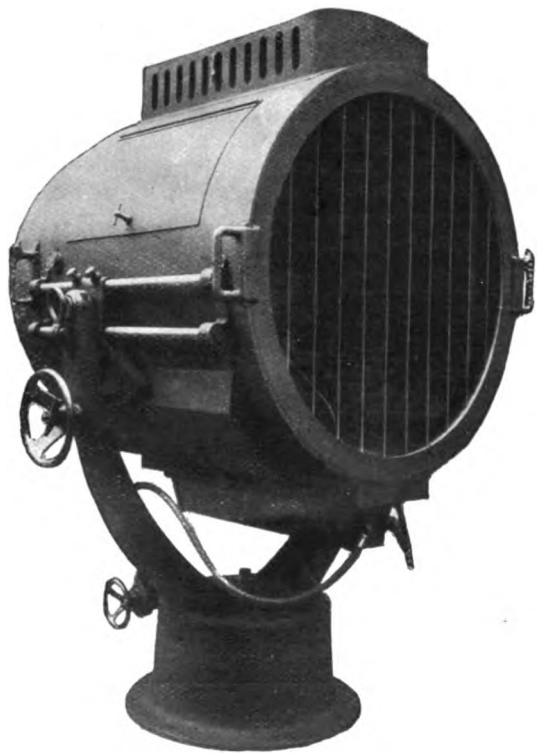
Regd. Office, **72, Mark Lane, London, E.C.**
Works, **Millwall, E.**


Digitized by Google

# SIEMENS
# Searchlight Projectors.

**MADE IN ALL SIZES FROM 25 cm. to 200 cm.**

**For Battleships, Merchant Service, Yachts, River and Suez Canal Navigation.**



**For Fortresses, Field Use, Mining, and all General Land Purposes.**

**Illustration of Class M.P. Projector.**
**60-Centimetre size, with adjustable Trunnions.**

Projectors can be fitted with Siemens' Patent Horizontal Automatic and Hand Lamp, or Horizontal Lamp for hand feed only. Mirrors of the metallic or glass parabolic type. Single or double Dispersing Lenses. Iris Diaphragm Shutter or Venetian Louvred Signalling Shutter. Electric Control is fitted for Fortress, Battleship, and other use, if desired.

**Full Particulars on Application to M Department.**

## SIEMENS BROTHERS DYNAMO WORKS LTD.,

**York Mansion, York Street, Westminster, S.W.**

Telephone: GERRARD 860. Telegrams: "SIEMBRALOS, LONDON."


Digitized by Google

# CONTENTS.


PAGE.

1. MANUFACTURE AND USE OF HAND GRENADES. By Lieut. A. L. C. Neame, R.E. ... ... ... .. ... ... ... ... ... ... ... 165

2. RECENT PROGRESS IN GEOGRAPHICAL WORK. By Lt.-Col. C. F. Close, C.M.G., R.E. *(With Map)* ... ... ... ... ... ... ... 169

3. RAILWAY SIGNALLING. By Capt. A. Gardiner, R.E. ... ... ... ... 181

4. THE PRESERVATION OF WINCHESTER CATHEDRAL. By 2nd Lieut. J. M. Smeathman, R.E. *(With Photos)* ... ... ... .. ... ... 185

5 THE MAIN UNDERGROUND TELEGRAPH SYSTEM OF GREAT BRITAIN. By Major W. A. J O'Meara, C.M.G., late R.E. ... ... ... ... ... 191

6. THE R.E. HEADQUARTER MESS (*continued*). By Lt.-Col. B R. Ward, R.E. .. 213

7. TRANSCRIPT :—

The Skerries Wireless Telephone. (From the *P.O. Electrical Engineers Journal* by 2nd Lieut A. H. Scott, R.E.) ... ... ... ... ... 217

8. REVIEWS :—

Recollections of a Life in the British Army. By Gen. Sir Richard Harrison, G.C.B., C.M.G., *p.s.c.*, late R.E. ... ... ... .. ... ... 219

Topographical Surveying and Sketching. By Major T. H. Rees, Corps of Engineers, U.S. Army ... ... . ... ... ... ... ... 221

War Songs ... ... ... ... ... ... ... ... ... ... 222

9. NOTICES OF MAGAZINES : —

*Kriegstechnische Zeitschrift.* By 2nd Lieut. A. H. Scott, R.E. ... ... 223

*Neue Militärische Blätter.* By Capt. E. G. Wace, R.E. ... ... ... 224

*Rivista di Artiglieria e Genio.* By Col. Sir Edwd. T. Thackeray, V.C., K.C.B., late R.E. ... ... ... .. ... ... ... ... 227

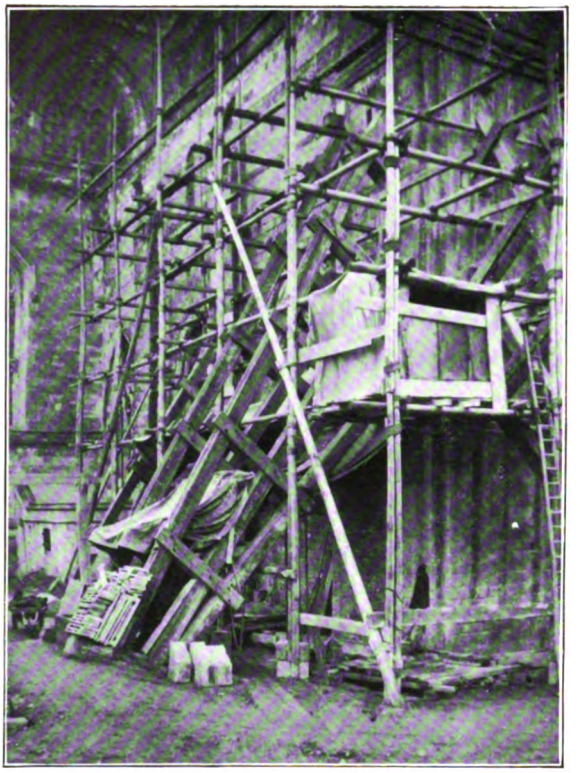
10. RECENT PUBLICATIONS OF MILITARY INTEREST ... ... ... ... ... 231


*Authors alone are responsible for the statements made and the opinions expressed in their papers.*

Digitized by Google

Digitized by Google

Digitized by Google



Shoring to E. Wall of N. Transept.
The lower planks cover the Excavations for Underpinning.
8′ of Water at Bottom of Excavations.

Shoring to S. Wall of S. Transept.

Digitized by Google

# *MANUFACTURE AND USE OF HAND GRENADES.*

*By* Lieut. A. L. C. Neame, R.E.

The diagram shows the form of hand grenade actually used in the attack against the defence position on Mooi Plaatz. It was purposely designed with a view to safety, being loaded with 1 oz. of black powder only, as experiments had shown that more might be dangerous. The grenade consists of four principal parts, the head, the tin cylinder, the handle, and the tail. Into the top of the head and the cylinder two wood blocks about $\frac{7}{8}''$ thick are fitted; the one in the head is fitted with a $1\frac{3}{4}''$ wood screw, the point projecting about $\frac{1}{4}''$; the block in the cylinder has a hole bored in it, into which the S.A.A. cartridge case, cut down to about 1″ in length, is fitted.

Below this comes the powder charge (enclosed in a serge bag for safety), and the remainder of the cylinder to within 1″ of the end is filled up with common salt (sand, etc., will do equally well), to give sufficient weight to the grenade. The handle is inserted into the end of the cylinder for a length of 1″ and is held in position by two tacks or small nails. At the end of the handle a calico tail about 2′ long is fixed, and this is kept coiled up and held together by a safety pin, until required for use.

The head has two horizontal and two vertical slots cut in it (only one of each is shown in the elevation), and in these the two small $\frac{3}{4}''$ screws (shown in section) engage. A thin metal strip divides the horizontal from the vertical slot. Two metal flaps are also fitted, which prevent the screws passing from one end of the horizontal slot to the other.

The grenade, as shown, is in the safety position, the head being prevented from being driven home by the screws coming in contact with the metal. To turn into the firing position, the two tin flaps are bent back, the head is moved round until the screws come up against the left edge of the horizontal slot, and the flaps are then bent down again. In this position, on impact, the screws break the thin metal strips and are driven down the vertical grooves, the point of the screw in the head strikes the cap of the S.A.A. cartridge and fires the charge.

*Materials used in Manufacture.*—One of the chief advantages claimed for this type of grenade is that it is made entirely from materials which would always be obtainable on service, and it is considered that it could, without difficulty, be manufactured with the tools carried by a field company, R.E.

Digitized by Google

The cylinder and head are both made of the linings of S.A.A. tins; the ordinary 1-oz. primer tins would suit admirably for this purpose, but it is improbable that sufficient would be obtainable on service. Other materials used are S.A.A. cartridge cases, wood, screws, tin tacks or small nails, wire, calico, and solder. The wood blocks in the head and cylinder need not be accurately turned to shape; rough work with a chisel would be quite sufficient, the blocks being held in position by screws if necessary. If calico was not available, many suitable substitutes could be found for it. On service the charge would be made up of any suitable explosive available (this is dealt with later).

*Time and Cost of Manufacture.*—The actual time taken by one man to make 120 grenades was 622 hours, or rather over 5 hours for each grenade. This time however included a considerable amount of experimental work, and on a future occasion the actual time of making the same grenade should be capable of reduction by half. Cost of labour is taken at the 4th rate of Engineer pay, or 1½d. per hour; a less skilled man should however be quite capable of doing the work.

Detail of cost of making 120 grenades is as follows:—

| | £ | s. | d. |
|---|---|---|---|
| *Cost of Material.* | | | |
| Deal 180′ at 1½d. per f.r. ... ... ... ... | 1 | 2 | 6 |
| Red wood, 20′, at 2½d. per f.r. ... ... ... | 0 | 4 | 2 |
| Screws, iron, 1¼″, 1 gross ... ... ... ... | 0 | 0 | 8 |
| Screws, brass, ¾″, 2 gross ... ... ... ... | 0 | 1 | 8 |
| S.A.A. tins, old, No. 24 ... ... ... ... | 0 | 1 | 0 |
| 15 yards calico at 3¼d. per yard ... ... ... | 0 | 4 | 1 |
| 120 S.A.A. cases, empty, at 5s. per 100 ... ... | 0 | 6 | 0 |
| F.G. powder, serge bags, loading, etc. ... ... | 1 | 4 | 0 |
| Total ... ... | £3 | 4 | 1 |

Cost of material for one grenade is 6·4 pence.

*Cost of Labour.*

622 hours at 4th rate of Engineer pay, viz., 1½d. per hour, £3 17s. 9d.
Cost of labour for one grenade is 7·8 pence.

*Total Cost of One Grenade.*

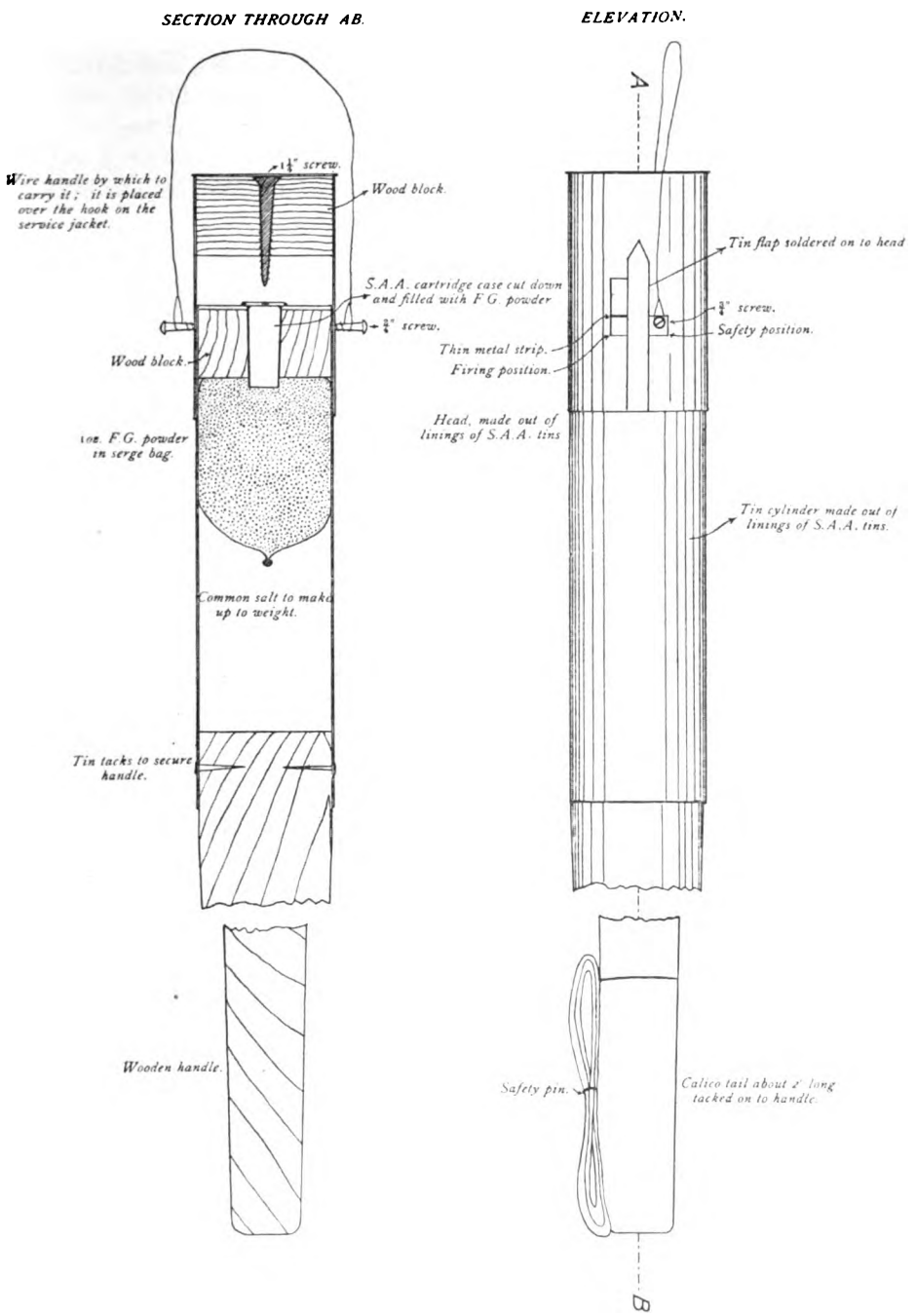
| | |
|---|---|
| Material ... ... ... ... ... ... | 6·4 pence. |
| Labour ... ... ... ... ... ... | 7·8 pence. |
| Total ... ... | 14·2 pence. |

This cost should not on a future occasion exceed say 10d. per grenade.

Digitized by Google

## HAND GRENADES.

### As Actually Used on Manœuvres.


SECTION THROUGH AB.
ELEVATION.
1¼" screw.
Wire handle by which to carry it; it is placed over the hook on the service jacket.
Wood block.
S.A.A. cartridge case cut down and filled with F.G. powder
¾" screw.
Wood block.
Thin metal strip.
Firing position.
oz. F.G. powder in serge bag.
Head, made out of linings of S.A.A. tins
Common salt to make up to weight.
Tin tacks to secure handle.
Wooden handle.
A
Tin flap soldered on to head
¾" screw.
Safety position.
Tin cylinder made out of linings of S.A.A. tins.
Safety pin.
Calico tail about 2' long tacked on to handle.
B

Digitized by Google

*Method of Using.*—The grenade is carried, by means of a wire loop on the head, over the hook of the service jacket until required for use; it is then taken off, the head is turned from the safety into the firing position, and the safety pin is withdrawn from the tail.

The tail should not be allowed to come unfolded, but should be taken as it is, together with the small end of the handle, and firmly gripped in the palm of the right hand. It should be thrown fairly well up into the air in exactly the same way as throwing a stone or a cricket ball; this gives the grenade time to steady itself during its flight and ensures that it strikes the ground head first. Its range if properly thrown is from 40 to 50 yards.

*Grenades for Use on Service.*—Several modifications in the above would be necessary to obtain a grenade suitable for use on service. Unfortunately, up to the present, time has not been available to carry out any exhaustive experiments. Grenades charged with dynamite and guncotton have been successfully fired by inserting one end of a short piece of instantaneous fuze into the cartridge case and attaching a commercial cap to the other end. The effect of these high explosives is however very local, and it is considered that the most damaging results to *personnel* would be obtained from a grenade made up of two cylinders about 2″ and 1″ in diameter respectively, the one fitting inside the other. The inner cylinder would contain a powder charge; the outer one old nails, bits of scrap iron, etc. It is hoped to shortly carry out some practical experiments with several different types of grenades against dummy targets.

*Generally.*—For the attack against the defence position 35 grenades were issued to each of the three battalions in the sub-district. The men detailed to use the grenades had had no previous practice with them, and the result was that they were very badly thrown; several failed to go off owing to not carrying out instructions, but, as far as could be ascertained, there was not a single case of failure where the grenade had been properly thrown.

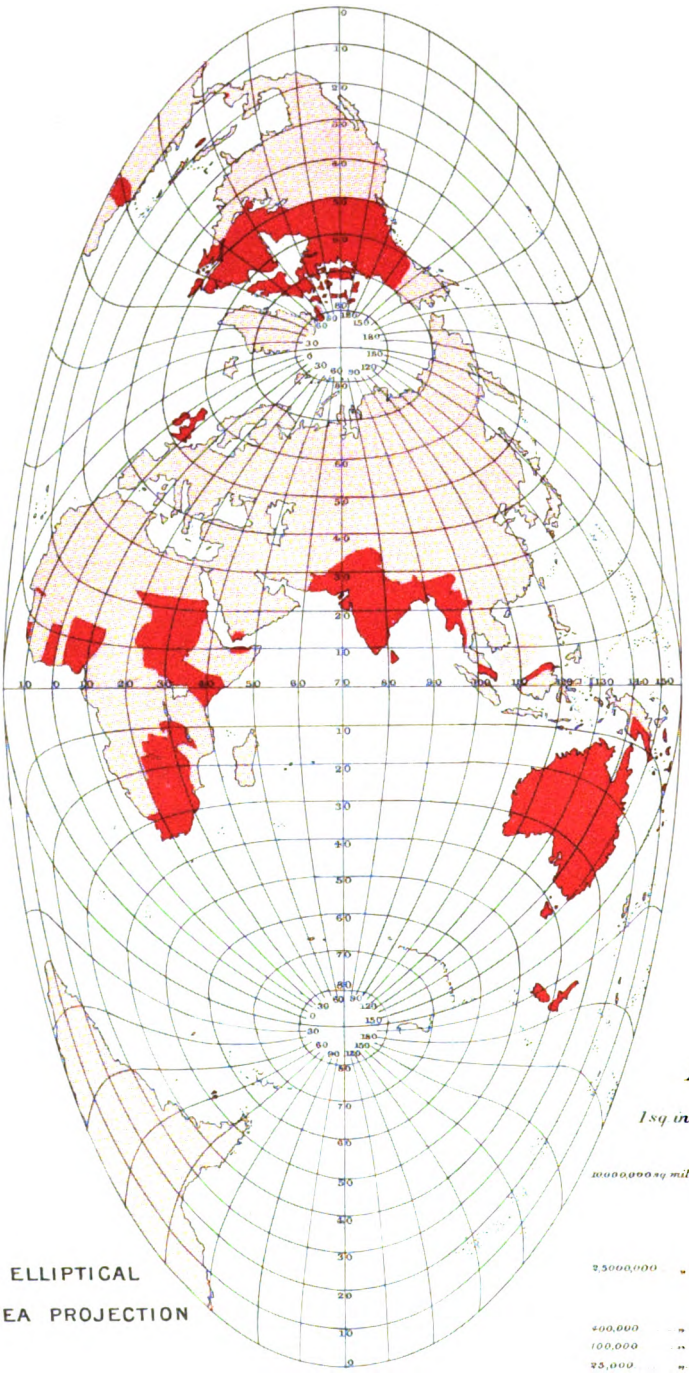
It would appear therefore that some sort of drill is necessary for throwing the grenades, and that a certain number of men in each battalion (if the infantry are to use them) should be thoroughly instructed in their use.

It is doubtful whether a grenade, capable of being thrown by hand, could ever be made very destructive, but according to reports on the Russo-Japanese War the moral effect is considerable.

Digitized by Google

Digitized by Google

# THE WORLD

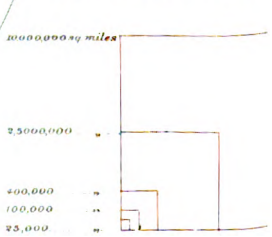


TRANSVERSE ELLIPTICAL

EQUAL-AREA PROJECTION

**Area Scale**

*1 sq inch = 10,000,000 sq. m*




Digitized by Google

# *RECENT PROGRESS IN GEOGRAPHICAL WORK.*

*By* LIEUT.-COLONEL C. F. CLOSE, C.M.G., R.E.

*Definition of the Word Geography.*—So many definitions of the word geography have been proposed at one time or another that it may be as well to begin with a brief discussion of the meaning of the term.

Dr. Mill defines geography as "The exact and organized knowledge of the distribution of phenomena on the surface of the earth." Prof. Hettner defines geography as "The science of the arrangement of things on the surface of the earth"—a definition of a very nebulous character. Mr. Chisholm puts his definition into this form:—"It is the function of geography, with respect to any class of phenomena that have a local distribution, to explain that distribution in so far as it can be explained by variations connected with place in the operation of causes whose operation varies according to locality . . . especially on human distribution, and hence on the life of man generally." Thus Mr. Chisholm frankly takes the view that the main problem of geography is the adjustment of man to the surface conditions of the earth.*

There is yet a fourth definition which sometimes finds a place in textbooks, and not a bad one either; it is "Geography is the study of man's physical environment on the surface of the planet, and of the interaction between it and the human race."

As the outcome of some of these various definitions we have a list of terms, such as economic-, political-, military-, historical-, geography. Now these terms cannot really be said to represent independent studies; they are rather the results of the application of geographical facts to economics, politics, the military art, and history. They are in fact, not branches of geography, but of the studies indicated by the first term of each compound word. There is an obvious parallel in the application of mathematics to a vast number of human sciences. Take for example the theory of errors; that is a true branch of mathematics. If applied to an anthropometric investigation, this application has no right to be called ethnological-mathematics. In the same way the application of the facts of geography to the military art does not result in military-geography—a term which is very likely to mislead the public.

Acting on the same system, it would be easy to construct a

* See the *Geographical Journal*, January, 1909.

Digitized by Google

series of terms, such as political-chemistry, or military-meteorology. No one doubts, for instance, the influence of climate on military operations, but such a study is a part of the military art, not of meteorology, and would in no way tend to increase our knowledge of meteorology.

The essence of geography must, in fact, consist in something peculiar to itself, and this is clearly the study of the surface of the earth; all the rest is the application of this study. I am not concerned in this paper with the applications of geography.

*Geography*, or the study of the surface of the earth, has three main divisions :—

(1). The study of the form of the earth as a whole and allied problems—*Geodesy*.

(2). The study of the details of the surface features of the earth—*Survey* and *Cartography*.

(3). The study of the origin of those features and of the changes which they undergo—*Physical Geography*.

We may say then that *Geography* consists of—

Geodesy.
Topography.
Physical Geography.

I am aware that this differs a good deal from the grouping adopted by my friend, Dr. Herbertson, at the Oxford School of Geography. But I have purposely tried to reduce the meaning of the word geography to its simplest terms, and thereby to define its elements as a branch of human knowledge. It is no doubt, for instance, useful to include the history of geography in a course of study, but the history of geography is no more part of geography than the history of mathematics is part of mathematics.

For the purposes of this paper therefore the subject will be considered under the three main headings—Geodesy, Topography, and Physical Geography, and the intention of the paper is to give, mainly by examples, an idea of the essentially geographical work which is now being carried on.

*Importance of the Subject.*—In view of the fact that so large a portion of this earth's surface is British territory, we have laid upon us, above all nations, the duty of investigating these subjects, and I hope to show that this duty is not being neglected. It may serve to fix the ideas to remember that the British Empire is practically the same size as Africa,* and only about three million miles less than the entire surface of the moon. The figures, in millions of square miles, are :—

| | |
|---|---|
| British Empire... ... | 11·29 |
| Africa ... ... ... | 11·30 |
| Moon ... ... ... | 14·68 |

* See *Plate* "The World."

Digitized by Google

## GEODESY.

It is impossible to attempt to do more than to illustrate by a few examples the geodetic investigations which are being carried on all over the world. I will mention only a few typical instances of such work in India, Africa, South America, and North America.

*India's Contribution to Geodesy.*—The chief contribution which has been made to geodesy by India, since Everest's time, is Colonel Burrard's investigation of "the intensity and direction of the force of gravity in India," in which he shows that there is a line of excessive density, a "buried chain of mountains," underlying the plains of Northern India, 150 miles distant from the foot of the Himalaya. It is not at present known to what cause this dense line is due, but the parallelism to the Himalaya indicates unity of origin. Burrard's line cannot fail to be an important factor in all discussions of the origin of that great range.

*Geodesy in Africa.*—In Africa the most important geodetic enterprise is undoubtedly the measurement of the arc of meridian along 30° E. This work, which was initiated by Sir David Gill in 1883, and was carried out, so far as concerns South Africa, mainly by Colonel Sir W. Morris, reached a point within 70 miles of Lake Tanganyika (working from the south) in 1907.

Another portion of this arc is at the present moment being measured. This is the portion in the neighbourhood of the Uganda-Congo boundary, stretching from 1° S. latitude to 1½° N. The party consists of Capt. Jack, R.E., Mr. McCaw, and two N.C.O.'s, R.E., and their Belgian colleagues are Mr. Dehalu, of Liège, and a Belgian officer. The party began work in March, 1908, and will finish about the middle of February, 1909. This undertaking is due to a happy idea of Mr. Read, of the Colonial Office, that advantage might be taken of the presence of the Uganda-Congo Boundary Commission to use a portion of the party, after the boundary survey was finished, to measure the arc. Four learned societies have contributed towards the expenses.

The Uganda Arc commences at the shores of Lake Albert, goes over the slopes of Ruwenzori, past the east shore of Lake Edward, until it reaches German territory on the south. The party have experienced much difficulty from mist and rain, especially in the neighbourhood of Ruwenzori. One of the stations was at a height of 10,000′ above the sea, and the observer found it most uncomfortably cold up there. At the moment of writing there is every reason to believe that the Uganda Arc is practically complete.

*The Arc of Peru.*—The Uganda-Congo Arc, crossing the Equator, has a rival in South America, the well-known Arc of Peru. In the year 1735 a French scientific expedition left France for the express purpose of measuring an arc in the neighbourhood of the Equator, an

Digitized by Google

arc which was to settle the question as to whether the earth was a prolate or an oblate spheroid. The expedition returned to France in 1744–45, having completed its labours. The members were Bouguer, La Condamine, and Godin. The length of the arc was about 3° 7′. In spite of its short length it has always occupied an important place in geodetic discussions, but it has long been recognized that, from the conditions of the case, the accuracy of this old arc was not equal to modern requirements.

The French Government therefore resolved, with the consent of the Governments of Ecuador and Peru, to measure the arc, and confided the task to the Service Géographique de l'Armée. Work was commenced in June, 1901, and was completed in July, 1906. The length of the new arc is 5° 53′, or about twice that of the 18th century arc. It is a very fine bit of work, consisting of 74 stations with 3 bases, 54 latitude, and 6 pendulum, stations.

Some accounts of the work have been published, from which it appears that the conditions were by no means comfortable. The work was chiefly on a high irregular plateau between the two cordilleras of the Andes, the average height of the stations being some 12,000′ above sea level. We may take the opportunity of heartily congratulating the Service Géographique on the skill and endurance which resulted in the completion of such an important measurement.

*Geodesy in the United States.*—To the United States we owe in recent years (i.) many mechanical improvements in geodetic methods and apparatus, (ii.) the execution of an immense geodetic framework covering the United States (which, it may be mentioned incidentally, has been found most useful by the Militia Department of Canada, for tying on the excellent Militia Survey to), and (iii.) the theory of isostasy, due (1889) to Capt. Dutton.

The theory of isostasy is briefly this:—If the earth is not composed of homogeneous matter, but some parts are denser than others, the figure will not be a spheroid; the denser matter will flatten the surface and the lighter matter will bulge. The isostatic figure is thus a deformed spheroid. There is reason to believe that the deposition of sediment on the sea-floor has the effect of causing the sea-floor to sink. Similarly the denudation of the adjacent land surface is accompanied by a corresponding elevation of that surface. Capt. Dutton says: "These subsidences of accumulated deposits and these progressive upward movements of eroded mountain platforms are, in the main, results of gravitation restoring the isostasy, which has been disturbed by denudation on the one hand and by sedimentation on the other." This is another matter which must be taken account of in discussing the difficult problem of mountain building.

Digitized by Google

## Exploration and Survey.

*Importance to Soldiers.*—One of Napoleon's maxims was "Une carte detaillée est une arme de guerre," and after our comparatively recent experience of the difficulties caused by want of maps in the South African War, there is no need to labour the point that a good map is a military necessity. Now it devolves principally upon our Corps to see that the Army is properly provided with maps of those regions in which British troops are likely to fight.

About 115 officers are now at work on surveys in the United Kingdom, India, Canada, South Africa, Tropical Africa, and elsewhere, and of these 90 are R.E. officers—about one-tenth of the total number of officers in the Corps. To these numbers we must add about 300 N.C.O.'s and men employed on the Ordnance Survey, and about 40 N.C.O.'s employed on surveys abroad.

The largest field of work is Africa, in which are employed 29 officers, 27 N.C.O.'s and a number of civilians. The largest administration is the Survey of India, which employs about 50 officers, of whom 36 are R.E. officers, and next to this in size is the Ordnance Survey, which employs 21 R.E. officers.

It is not necessary to enter into any detailed description of the surveys going on in Africa, because these have been the subject of recent lectures. Briefly, so far as British territory is concerned, topographical surveys are in progress in the Cape Colony, the O.R.C., East Africa, Uganda, and Southern Nigeria, and cadastral surveys are in progress in the Gold Coast, the Anglo-Egyptian Sudan, and most of the other protectorates.

*The Survey of India.*—In India the principal event to chronicle is the report of the Committee on the Survey of India, which in 1904–5 investigated the whole question of the mapping of India. The Committee reported that it was necessary to make such arrangements as would ensure the topographical mapping of the whole Indian Empire of 1,780,000 square miles within the next 25 years. The Committee laid the greatest stress on the provision of maps for military purposes, and made recommendations for the improvement of the quality of the published maps.

Major Hedley, R.E., was deputed to reorganize the map-printing office in Calcutta, and was lent by the Ordnance Survey for that purpose. He spent two years in Calcutta and effected a marked improvement, and the maps now printed at Calcutta are greatly superior to their predecessors.

As regards the recommendations of the Committee in the matters of the scales of the maps and the organization of the Department, these have been the subject of much correspondence between the Government of India, the local governments, the India Office, and the War Office. A final decision is, it is believed, almost arrived at.

Digitized by Google

*Sven Hedin.*—The most sensational of recent explorations in Asia are the journeys of Dr. Sven Hedin. Brief accounts of these journeys have appeared in all the papers, and it is well known that Sven Hedin left Leh in August, 1906, and for two years carried out a remarkable series of explorations in South and South-West Tibet. He lectured in London on the 8th of February, and those who attended the lecture heard an account of a magnificent piece of exploratory work from an intrepid and accomplished traveller.

Dr. Sven Hedin has explored, during the course of his two years' wanderings, an area of some 50,000 square miles lying between the high peaks to the north of the Brahmaputra (some of which had been fixed by Ryder and Rawling) and the old routes of Nain Singh, Littledale, and of Sven Hedin himself.

It is doubtful if such great mountain masses should be called a "range." We can get some idea of the complexity of mountain structure by examining photographs of the excellent model of Switzerland which is in the University of Geneva. The only simple lines are the river valleys. It must not be supposed that, even after Dr. Sven Hedin's journeys, we have anything at present beyond an exploratory survey of these intricate mountains of Southern Tibet, such as might be derived, for instance, in the case of an unexplored Switzerland, from four travellers' journeys across the country from north-west to south-east, and from the trigonometrical positions of three peaks overlooking the Rhone Valley.

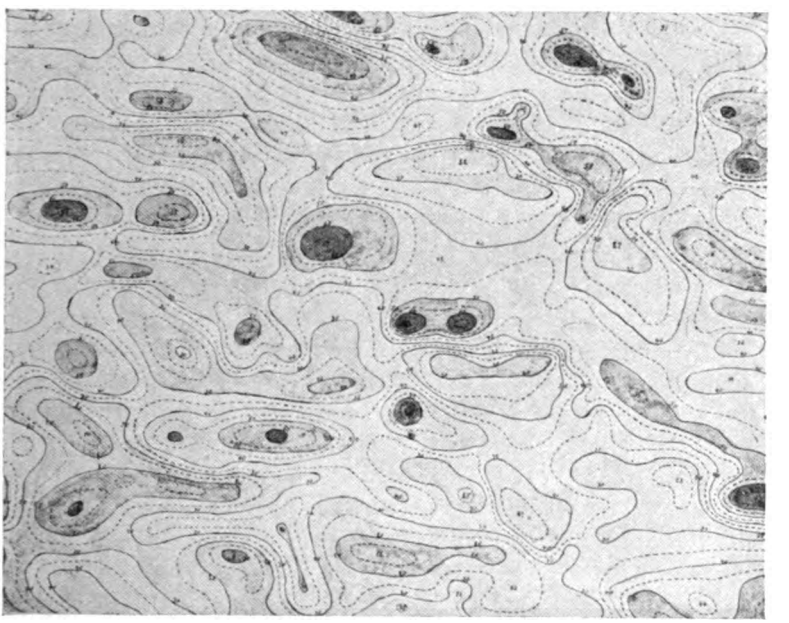
Dr. Sven Hedin has proposed to call these mountain masses the "Trans-Himalaya." Objection has been taken to this name, and it is understood that Dr. Sven Hedin now proposes "Anti-Himalaya." The question will no doubt be debated by those who have an expert knowledge of the literature of the subject.

*Improvements in Survey Methods.*—Improvements in methods of survey and in instruments have their importance, but it is an importance which is commonly overrated. They are only of serious value if they render surveying cheaper, or enable work to be done which would otherwise be impossible. This criticism does not apply to photo-surveying, which, though not required for ordinary use, will occasionally enable the explorer to do things which would be otherwise impossible. The most ingenious, as well as most practical, form of photo-surveying is that devised in different ways—by Pulfvich in Germany, Fourcade in South Africa, and Capt. F. V. Thompson, R.E., in England. In this the stereoscopic principle is made use of, and Capt. Thompson has shown that the stereoscopic positions, in which the automatic judgment of the observer comes into play, are about twice as accurate as those determined from the same photographs by independent intersections. Moreover, by using the stereoscopic principle, it is not necessary to observe any definite object; a point may be chosen, for instance, on the side of a grassy

Digitized by Google

hill, and its distance, direction, and height determined. This is strictly a new principle.

*Plan of Sea Waves.*—The method has been applied by Dr. Kohlschütter to making a contoured plan of a momentary position of the waves of the sea. He was the first to think of this application of the stereoscopic system, and for the first time in history we can now examine critically and at leisure the form of those waves which cause some of us so much inconvenience.



*The First Contoured Plan of the Sea Waves.—By Dr. Kohlschütter*, 1907.*

*Improvements in Cartography.*—The foundation of all modern systems of representing hill features is of course the contour, or the approximate contour. In the case of a highly accurate survey like the Ordnance Survey the contours are actually marked out on the ground by levelling, and are fixed on paper with the same kind of accuracy as the detail. But the Ordnance Survey is in this respect a survey apart. In almost all other national surveys the contours are approximate only. Now in drawing approximate contours the faculty of judgment comes into play, and the more rapid the sketching the more necessary it is for the sketcher to have an eye for hill forms.

*Character in Contours.*—In certain foreign maps of Africa the hill features are represented by very conventional, rounded form-lines, and we all of us know how difficult it is to read a map in which the characteristic features are not brought out. The opposite fault is

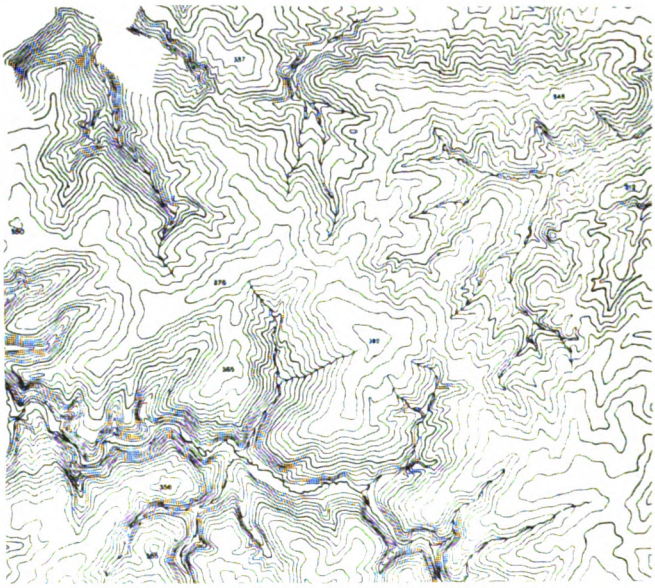
* Printed by permission of Dr. Kohlschütter.

Digitized by Google

more rare, the fault of over-emphasis. In maps which fail in this respect too much angularity is given to the features, and the sketch becomes a sort of caricature of nature. However, a good caricature is better than an expressionless sketch.

It is in small refinements that the difference between good and bad hill drawing is shown. Sometimes a good deal can be learnt by reducing down photographically the contours of an accurate map. The attached example is such a reduction. Much also can be learnt from the study of good models.

Every hill contourer should know enough physical geography to understand the different varieties of hill forms.



*Example of Nominally Angular Contours.*

*Legibility of Modern Maps.*—There has been a marked improvement in recent years in the legibility of the printed maps. There is a general tendency to use colour freely. Many of us here can remember the time when the only maps purchasable were, in England, the engraved black 1-inch map, and in France the engraved black $\frac{1}{80000}$. Not only is improvement shown by the use of colour, but by the adoption of new methods of representing hill features and relief generally.

The most important advance in the 19th century was the introduction (popularized in England by Mr. Bartholomew) of the method of indicating ground between certain selected heights by special tints; maps printed on this system are sometimes known as "layer" maps.

The next step is to combine the "layer system," which shows the main features, with the shade, which is so useful for showing minor features. This was done (for the first time in a normal topographical

Digitized by Google

map) in the Ordnance ½-inch layer map of England, of which the publication was commenced in 1908. It is in this direction that progress is probably to be looked for in the immediate future. A new "layer" map of Scotland is being got out by the Ordnance Survey, and, benefiting by the experience gained in producing the English ½-inch, we may expect that the Scotch ½-inch will be in advance, as regards legibility of the relief, of any map hitherto published.

$\frac{1}{1000000}$ *Map.*—Whilst dealing with cartography it will be as well to mention the progress made by the $\frac{1}{1000000}$ map. At the International Geographical Congress of London in 1895 a resolution was passed in favour of the production of maps on a uniform system on this scale. Something, but not very much, has been done by ourselves, the French, and Germans to carry out this intention. A considerable step was taken at the International Congress at Geneva in July—August, 1908. The Congress, at the instance of the American delegates, laid down in greater detail the character of the map. It was decided, for instance, that the names should be in the Latin character, that the map should be a layer map, that the contours should be at intervals of 200 mètres. Many other matters were decided, and if, as is to be hoped, the countries interested adopt the recommendations and come to a complete agreement on the subject, we shall, if we live long enough, find the greater part of the earth's surface mapped in a uniform and systematic manner, and shall be able to purchase maps of the same familiar type in every civilized country. It is a pleasing idea to think of the civilized inhabitants of this small planet agreeing together to depict its surface in a way which all shall understand.

*Canada.*—Before concluding this very brief sketch of some notable matters in the domain of surveying and cartography, it should be mentioned that the most important survey initiated in the British Empire in recent years is the 1-inch-to-1-mile survey of Canada, now being undertaken by the Department of Militia and Defence. This survey, commenced about four years ago, has turned out some remarkably good maps. The credit of this work is chiefly due to Capt. Anderson, R.C.E. About 14,000 square miles have been completed in the field, and the work progresses at the rate of about 4,000 square miles a year. The survey is at present confined to the Provinces of Quebec and Ontario.

## Physical Geography.

*Physiography of the Nile.*—Perhaps the most important publication of recent years, especially from the practical standpoint, is Capt. Lyons' account of the "Physiography of the Nile." One of the factors dealt with in such a study is the distribution of rainfall, and this is an instance of the way in which one branch of knowledge borrows from another; but the distribution of rainfall is itself,

Digitized by Google

amongst other causes, largely dependent on the character of the hill features.

All studies which do not deal with life are closely related and allied, but in order to ensure definiteness of knowledge we have to divide them into groups. All such knowledge is essentially one, but the methods of human thought requires its conventional division. The finest results of investigation are arrived at by defining, systematizing, and grouping. A science must limit its field and define its objects; a definition like Hettner's, "the science of the arrangement of things on the surface of the earth," is too vague to be of value.

Amongst other matters in the domain of physical geography, which have attracted considerable attention lately, may be mentioned three practical subjects, viz., the transporting power of rivers, coast erosion, and earthquakes.

*Matter in Suspension and Solution in Rivers.*—Dr. Strahan, chairman of the Research Committee of the R.G.S., has been investigating the question of the amount of matter carried away from the land by rivers. The Medway is one of the rivers selected for examination, but the results are not yet available. I mention this question particularly to show that physical geography is largely a matter of definite investigation, as every science should be.

It is, of course, very well known that the denudation of the land by water is a fact of primary importance in geology and physical geography, and the effect of the weight of the deposited sediment in disturbing the isostatic equilibrium has already been alluded to. Sir Archibald Geikie many years ago gave some figures which will serve to render the quantitative effect of denudation more definite. Thus the solid matter carried every day by the Mississippi into the Gulf of Mexico is about a million tons; and, as an instance of the amount of matter in solution, the learned Bischoff "calculated that the Rhine carries past Bonn every year enough carbonate of lime chemically dissolved in its water to form 332,000 millions of oysters."

*Coast Erosion.*—The loss of land due to coast erosion is a matter which is frequently referred to in the Press, and has been recently investigated by a Royal Commission. The evidence was issued a few days ago in the form of a bulky volume. In addition to coast erosion, the Commission considered the very interesting problem of the re-afforestation of the United Kingdom, and this latter subject has rather swamped the former. However, as regards coast erosion, the evidence is briefly to the effect that in about 40 years England has gained, above H.W.M., on the whole, about 30,000 acres, chiefly due to reclamation at Sunk Island, in the Humber, and also in the Wash and in Morecambe Bay, and also to natural accretion at Saltfleet and elsewhere. The principal erosion is on the East Coast and on the Sussex coast. Curiously enough, England has lost 31,000 acres on the L.W. line.

Digitized by Google

Scotland has gained 4,000 acres on the H.W. line and lost 8,000 acres on the L.W. line, a net loss of 4,000 acres (if the foreshore is counted). Ireland has gained 7,000 acres on the H.W. line and lost 7,500 acres on the L.W. line.

Colonel Hellard, who, as Director-General of the Ordnance Survey, gave evidence on the subject, says that he has come to the conclusion that agricultural land is not worth saving, and that land of higher value must be saved, if at all, by the action of local authorities, always excepting a few cases which might be considered of national importance.

*Earthquakes.*—A very important branch of physical geography is the study of earthquakes, to which our attention has been especially drawn in recent years by the destruction of San Francisco and Jamaica, and only the other day by the exceptionally disastrous earthquake in Sicily and the adjoining part of Italy.

The ultimate cause of earthquakes is not known, although many conjectures have been made, but we sometimes know a good deal about the proximate cause. Perhaps the best earthquake to study is that which happened on 15th April, 1906, at San Francisco.* In this case a slip occurred along an old fault. The movement was entirely horizontal and the average slip was 11 feet, although in some cases there was a movement of as much as 20 feet. "For nearly 200 miles there is a fracture on the face of the land, and everything traversed by the fracture is dislocated, the part on the south-west side having apparently moved toward the north-west, and the part on the north-east side having apparently moved toward the south-east." In some places the line of fracture is inconspicuous, but generally it appears as a large crack. In the Report of the United States Geological Survey an earthquake is described as a jar occasioned by some violent rupture, which may result from an explosion, but more commonly from the sudden breaking of rock under strain. "The great majority of ruptures include not only the making of a crack . . . but the sliding of the rock masses on the two sides of the crack." In the case of the San Francisco earthquake the slip took place on the plane of an old fault. It is obvious that when the crust of the earth is adjusting itself under strain the cracking and slipping is naturally to be expected on old lines of rupture.

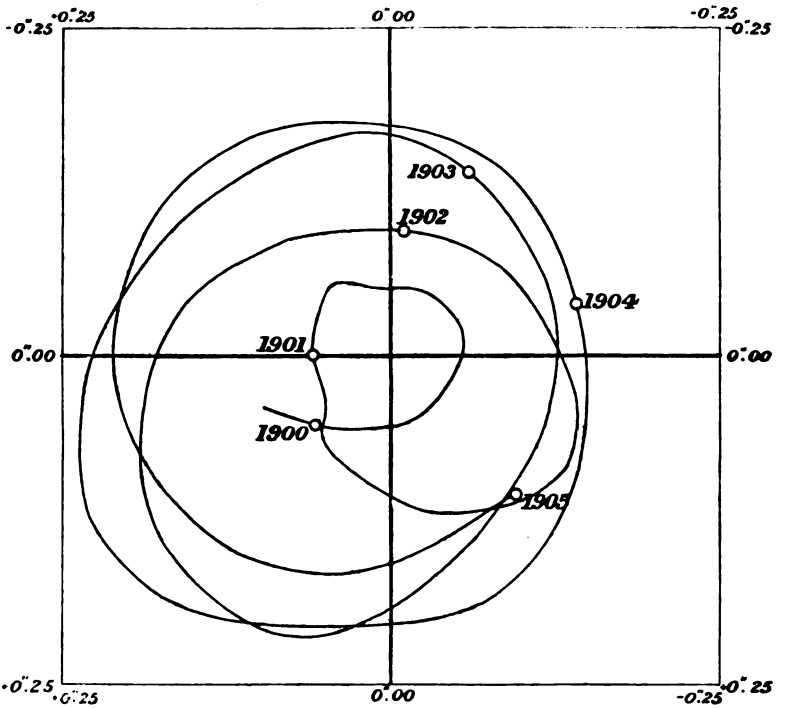
In and near San Francisco the earthquake had a duration of about one minute, the motion consisting chiefly of horizontal oscillations. "The motion was jerky and included abrupt phases that were almost blows." The range of the oscillations is believed to have varied from 2 inches to about 6 inches.

*Latitude Variation.*—It has been suggested, I believe by Dr. Milne, our greatest authority on earthquakes, that there is perhaps some connection between the occurrence of earthquakes and the phenomenon of "latitude variation." But whether this is the case or not,

* See the Reports of the U.S. Geological Survey.

Digitized by Google

"latitude variation" clearly indicates that the earth is subjected to periodically varying stresses, the effect of which is that the axis of the earth is not a fixed line as regards the earth itself, but moves in such a way that the pole describes an irregular curve in the neighbourhood of the mean pole. Its greatest range is 0″·4, or about 40 feet. Of course this movement has been known for a good many years now. It is one which it is absolutely necessary to take account of in geodetic operations, and, as just stated, it is one to which attention must also be paid in considering the strains which may result in rupturing the crust.




*Track of the North Pole of the Earth Axis.**

*Interdependence of the Three Divisions of the Subject.*—And this is another illustration of the fact that geodesy and physical geography are intimately allied ; and knowing how much topography depends on geodesy, and geodesy on topography, and that the study of physical geography is impossible without topography, and that it is impossible to be a good topographer without some knowledge of physical geography, we may safely say that the three are interdependent, and are in fact the three main divisions of that branch of human knowledge known as Geography.

* Extracted from *Resultate des Internationalen Breitendienstes*, Vol. II., 1906.

Digitized by Google

# *RAILWAY SIGNALLING.*

*By* CAPT. A. GARDINER, R.E.

HAVING recently examined a considerable number of the methods of power signalling and interlocking at present advocated in England, I cannot let the remarks made on pp. 363 and 364 of the December *Journal*—comparing the "all electric" and "high pressure" systems unfavourably with the "low pressure"—pass, without putting forward the other side of the question as to which of these systems has the balance of advantages in its favour.

Lieuts. Fenton and Tyrrell's report is open to the interpretation of being the very latest verdict, but, as I do not look upon the "low pressure" system as the best in situations where conditions at all admit of other methods of working, it is only fair on the other systems to record my opinion also.

At the same time I do not wish to be looked upon as rabidly anti-British pneumatic—I am not. It is a very clever system, having very many points of advantage over manual working, but the "low pressure" system, as described, has to my mind two or three serious defects in its principles of working. The first is shown in *Fig.* 8 of the Report, where the point switches are moved by a rod and stud action in connection with a motion plate, and the plate itself—by another rod and stud arrangement—sends back the indication which completes the lever movement, and thus frees the mechanical interlocking of the signal levers. The point switches (either one or both) may conceivably become separated from the motion plate, either by being "trailed through," or by some other accident or neglect; and the motion plate might then send back the "all correct" indication without really having moved the switches. It is true that there is a lock rod and stud, but this may easily be out of order too (and usually would be in the case of a "trail through"). The only absolutely sound principle for such indications is that they shall be controlled directly by the switches themselves, and *not* by the means by which it is intended to operate those switches. This principle is not infringed in the other systems referred to.

Actually there is, I believe, usually an electric check in addition to the pneumatic indication; but a second check should be superfluous, and the pneumatic contrivance, if it cannot be absolutely relied upon, becomes really merely the lever replacer, an operation upon which I do not place any very great store.

Digitized by Google

The next arrangement, which strikes me as wrong, is that by which the signal is actively replaced to danger by air pressure (*Fig.* 9). Independence of gravity is claimed as a "characteristic" of this system. Personally, I should prefer to rely upon the direct action of gravity rather than upon the correct working of a somewhat elaborate series of valves and air pressures. In this Company's auto-signal the disparaged aid of gravity has admittedly been fallen back upon. There may be some very good reason why a similar arrangement is not adopted in yards, but I suspect that it is chiefly with a view to securing the automatic lever replacement, and if so it seems to me to be too dearly bought. In the penultimate paragraph of the Report reliance upon gravity appears to be eventually claimed for all signals, and not merely for the auto-signal; but even if it be the case that cessation of the holding-off pressure suffices to return any of the signals to danger, the intermediate mechanism—before this cessation can be ensured—is more elaborate than in the electrically controlled systems, where the mere failure of a current causes the reversion of the signal by gravity to the danger position.

The last objection which I will raise to principles is of a somewhat similar nature to the above, and this is to the electric signal "replacement" (*Fig.* 11) being effected through yet another cycle of operations, viz., the train—de-energizing the track relay—opens the circuit of the electro-magnetic cut-off valve, admitting air to a piston which moves the lever *in the signal cabin*, and only then gets us back to the already, to my mind, dangerously long cycle which eventually leads up to the active return of the signal, by air pressure, to the danger position. I would require some convincing before I accepted such a device in preference to that of the Westinghouse "high pressure" (or more correctly "electro-pneumatic") system in which the train, de-energizing the track relay, opens the circuit of an electro-magnetic valve at the signal itself, releasing the pressure that has been holding it "off" and allowing it to revert by gravity to danger. In the "all-electric" systems the arrangements are equally simple and direct.

The statement of characteristics does not seem to me to be entirely beyond comment.

"(1). It requires no force but air."

Is this strictly accurate? I think it we had "no force but air" we should have to sit a long time before our points moved! I am not quibbling. My point is that we are simply using our force of steam or other power to compress air, as a means of conveying that power to the points and signals, instead of using it to generate some one of its other transmissible forms. Air-compressing machinery is hardly less complicated than a dynamo; moreover, in some cases, electric current will even be found actually employed in driving a motor to compress air (most of which will subsequently be lost in leakages), instead of—as it could do—directly operating the yard!

Digitized by Google

"(2). The air pressure is always low. . . ."

See also Claim 1 over the "high-pressure systems."

The air pressure in the distributing mains is anything but low (80 lbs.). These extend for miles, and require provision against condensation, freezing, etc., and then pressure-reducing valves to bring down to 15 lbs., 7 lbs., or 10 lbs., for operating purposes.

"(3). . . . quite independent . . . of gravity."

I have expressed my doubts as to the value of this characteristic.

"(4). Except when a switch or signal is being moved . . . all . . . pipes are subject to atmospheric pressure and no more."

This is doubtless to reduce leakage losses in the elaborate maze of operating and indicating pipes, more especially in stations where movements are comparatively infrequent and the idle intervals correspondingly long; also to avoid the risk of unexpected operations resulting from leaky valves, etc.; but it involves considerable losses of compressed air and also appreciable slowness of operation, since the lengths of piping between the signal box, and the points or signal, have to be charged up again before they can again perform work.

"(5) and (6). The automatic return of the lever."

This is a very neat operation. It is very attractive to see the signalman with his hand on the next lever ready to pull it over the instant the controlling lever, or levers, completes its, or their, movements all on their own account. But when one takes into consideration that no physical effort is required to move these levers, that they take up so little width that the whole frame is within easy reach of the operator, with but little delay in shifting his position, and that the return of the lever is *not* instantaneous upon the completion of the point or signal movement, but takes quite an appreciable time while the indicating pipe charges up and operates the relay which works the replacing piston, the real value of this characteristic becomes doubtful. Certainly I should not myself sacrifice one iota of safety to secure it, nor should I be prepared to accept much additional expense or complication of mechanism.

As regards the three chief functions of a railroad switch and signal device, I would put No. 3 of the Report a very long way *first*; and as I have explained, I am not satisfied that this system complies with this requirement as fully as it might do.

The "marked" advantages claimed over the "all electric" are really not overwhelming. As far as (2) and (3) are concerned, if the electric current has to be there at all, it is comparatively immaterial whether it be in sufficient strength to ring a bell or not; in fact, I am inclined to think a more tangible presence would probably be the easiest looked after, while the degree of intelligence required to run air-compressing machinery at the compressing stations, keep pressure-reducing valves in order, add 50 per cent. when occasion demands, and generally maintain an elaborate pneumatic system is probably

Digitized by Google

not less than that required to look after any form of battery or of simple electric-generating or electrically-operated plant.

As regards lower primary cost, it would be of considerable interest if Lieuts. Fenton and Tyrrell would state the grounds on which this advantage has been urged. I absolutely failed to get anything like a definite comparative estimate of primary costs; but looking at the comparative amounts of mechanism in each, as well as judging by such figures and quotations as I was able at all to get hold of, the electric and electro-pneumatic systems appeared to be quite able to hold their own, while in subsequent working expenses the advantage appeared to lie very heavily indeed with the electric systems, mainly owing to the enormous losses unavoidable with compressed air. That the "electro-pneumatic" panned out better in this respect than the "all air," appeared to be mainly due (1) to the limitation of the compressed air strictly to power purposes, all control being electric, and (2) to the far greater frequency of operation (and consequently less time standing idle except for leaks) on the District Railway as compared with the London and South-Western.

Since writing his article in the December *Journal* Lieut. Fenton has probably had a good opportunity of studying a very carefully worked-out "all electric" installation on the Siemens system, modified by Mr. Sayers, of the Midland Railway; and it would be interesting if he could find time to give us a report on that, and say whether his views as to the advantages over the electric of the pneumatic system have undergone any modification.

To my mind the advantages of the "all electric" lie chiefly in the possibility of direct control of the motive power by the signalman's lever, without the intervention of intermediaries, such as relays, etc.; the advantages of insulated cable over pipes for power transmission purposes (avoidance of leaky joints, condensation, necessity for providing for expansion and contraction, etc., etc.), as also for subsequent alteration; the instantaneous response of the motor mechanism to the signalman's "orders," and the direct control of the back indication by the object itself which is intended to be moved by the motor; the greater fineness of detection for such indication that electric contacts admit of as compared with a somewhat clumsy air valve, and its instantaneous transmission to the signalman; and, finally, the simpler mechanism of a motor or an electro-magnet as compared with air relays, 7-lb. and 15-lb. pipes, and air motors, which must, if out of order, be attended to *in situ*, instead of being capable of being pulled out and replaced in a few minutes, and sent into shops for skilled attention.

The British Pneumatic Company are, I understand, developing an "all electric" system, which, as being one of the latest devised, should be the most up to date and of great interest to all concerned in railway signalling.

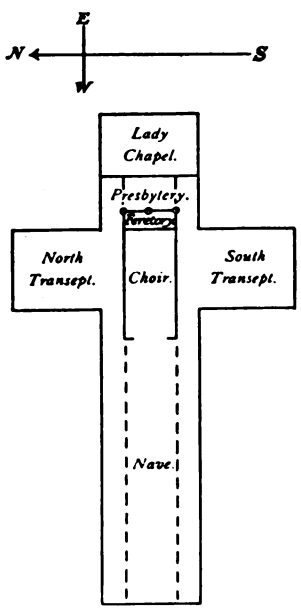
Digitized by Google

# *THE PRESERVATION OF WINCHESTER CATHEDRAL.*

*By* 2ND LIEUT. J. M. SMEATHMAN, R.E.

WINCHESTER CATHEDRAL, which occupies a large open space towards the south-east of the town, is at once one of the largest and most interesting in England. According to the *Imperia Gazetteer* it was first completed in 648, but about 870 suffered so much from the ravages of the Danes, that it became almost ruinous. The present structure, commenced in 1079, and completed in 1093, has since received so many additions and undergone so many alterations, that it has lost much of its unity of design, and has assumed a form which makes it difficult to say whether the early Norman or later English is predominant. It is in the form of a cross, with a square tower rising from the point of intersection to the height of 138′, though not more than 26′ above the roof. The whole length, from the west entrance of the lady chapel to the east end, is ·545′, the width of the transepts being 186′. The interior

*Rough Sketch Plan.*




Digitized by Google

consists of a nave 250′ long and 78′ high; aisles separated from it by a double range of pillars 12′ in diameter, a choir 40′ wide occupying the lower part of the central tower, and lighted by clerestory windows; and transepts containing several very beautiful chapels and altars. The roof is elaborately groined and enriched with delicate tracery, armorial bearings, and other ornaments; the throne, prebendal stalls, and pulpit present excellent specimens of carving. There are also numerous monuments, amongst which those of Hardicanute and William Rufus and Bishops Fox, Gardiner, and Wykeham, possess much historical interest. The most imposing part of the structure is the west front, consisting of three deeply-recessed and highly-enriched porches, with an ornamental gallery above, a large and beautiful window with rich mouldings, several massive buttresses and pinnacled towers, and a gabled termination crowned by a canopied statue of William of Wykeham.

Up to a comparatively recent date the building was thought to be in the highest state of repair, but—owing to cracks and other damage appearing a few years back—the foundations were carefully examined, and a very serious state of affairs was found to exist. It was discovered that the cathedral was originally founded upon a very bad site, which in ancient times was either a bog or a river bed. The foundations were placed in a waterlogged bed of peat, which is of varying thickness, owing to the shelving surface of the gravel beneath it. It becomes deeper from west to east, and its upper surface is about 10′ from the surface of the soil above it. The whole structure has settled down into the bed of peat, and moreover has settled unequally, owing to unequal distribution of loads and inequalities in the depth of the peat. The original builders seem to have been afraid of this settlement, as they placed layers of beech logs under the foundations. As the layer of logs is no wider than the walls, it is evident that it was placed there more to secure an initial foundation than to extend the area bearing on the soft peat. The logs are still in a wonderful state of preservation, some even retaining the bark, but they did not of course prevent the foundations from sinking. The eastern end, being on a deeper bed of peat, has settled considerably more than the western end, which has scarcely moved at all, and the result is that the whole structure leans towards the east. Owing to local differences of loading and depth of peat, this settlement is not regular, but varies all over the building. The ends of the transepts have, for instance, sunk more than other parts, and great cracks occur right across the transepts through both walls and the roof.

Some time ago attempts were made to stop the settlement, which was making itself apparent. To do this without disturbing the existing foundations piles were driven down on the outside and inside of

Digitized by Google

these foundations and close to them, with the intention apparently of boxing in the peat and preventing it from spreading. There was however another fault which the piles could not remedy. Owing to the softness of the peat, the weight of the walls and of the buttresses did not properly counterbalance the roof thrust. This was due to the buttresses being founded in the soft peat often at a less depth than the walls, causing the inside edge of the wall to tend to become the centre of revolution. As the wall leant outwards the roof sank, and its thrust of course became more horizontal and its turning moment greater. The buttresses were only founded 6′ into the earth, while the walls were founded about 11′.

Below the peat is a stratum of gravel, and the only way of preventing further settlement was by digging out the peat and continuing the foundations down to it; even then, for the gravel to carry the building safely, the foundations require to be 12′ thick. The maximum depth of the gravel below the surface of the earth is about 30′, and concrete footings are therefore being added of a depth varying from 13′ to 19′. Great difficulty is found in some places in placing these foundations owing to the presence of large quantities of water, which rises continually through the gravel, and the method used is described later.

In addition to this, owing to the irregularity of the settlement, the roof did not simply flatten out, but cracked in places right across. This is corrected, as described later, by tieing together the opposite sides of the roof, and so converting the vaulted roof into a truss with iron tie-bars and arched struts.

Approximately in the centre of the building there are three pillars separating the presbytery from the feretory. These pillars are the only part of the building which have remained upright, and the building leans outward from them to the north, east, and south. At the same time individual walls lean outwards, thus distorting the arches connected to these pillars.

Dealing first with the settlement to the east, the first noticeable feature is a large crack across the presbytery. This leaning to the east was noticed some centuries ago, and apparently an attempt was made to stop it by building on a lady chapel as a large buttress at the end. This was very heavily made, and its foundations were not sufficient to hold the load due to the settlement of the presbytery. The result is that the lady chapel and presbytery have sunk together, mostly at the point where they meet, and, as the eastern end of the lady chapel has leant outwards as well, a large crack has been formed across the lady chapel.

The lateral—or north and south—leaning is most noticeable about the transepts, which have settled in a similar manner to the presbytery. The three pillars between the presbytery and the feretory have acted

Digitized by Google

to a certain extent as an anchor, and so the south transept in leaning bodily to the south has not only cracked right across, forming a gap 2″ wide at the bottom and 12″ at the top, but has also broken away from the south wall of the presbytery, carrying with it part of the south wall of the vestry, and so creating a cleavage of about 6″ at the top of this wall. Owing to the eastern wall of the south transept leaning eastwards at the centre, it has at the top become curved to a very dangerous degree. The north transept has settled in the same manner, but not quite so extensively. The combined movement has tilted the tower considerably out of the vertical.

The following figures will give an idea of the degree of stress to which the walls have been subjected:—

The eastern end of the south wall of the presbytery is 2′ 4″ away from the vertical at the top.

The top of the pillar inside this is 1′ 11″ to the south of the vertical.

The south wall of the presbytery slopes downwards from west to east at a slope of 3″ in 7′.

The eastern wall of the lady chapel at the top is 5½″ to the east.

The tower at the same height is 3″ to the east.

The western end of the south wall of the presbytery leans 6″ to the south and 3″ to the east.

The south wall of the feretory leans 12″ to the south.

The above clearly shows the dangerous condition of the cathedral, and the following is a short description of the steps which are being taken to preserve it. In the first place solid foundations resting on the gravel are being provided, and this is being done as follows:—As previously mentioned, concrete has to be filled in to a depth of between 13′ and 19′, and of a width varying from 12′ to 14′. In every case water continually rises through the gravel and is pumped out where possible, but in many places about 8′ of water are met with, and a diver has then to be employed. The process is similar in all parts excepting where in deep water it is necessary to form a watertight layer, and the following is therefore a description of the work where this has to be done. First of all piles are driven round a section of about 5′, which is to be underpinned. The earth and the peat are next excavated down to the level at which the diver becomes necessary. He then digs out the remainder of the peat and places concrete in layers of bags over the gravel. The bags of concrete are laid to a depth of about 3′, and this forms the watertight bed upon which the workmen build the footings, after all the water has been pumped out to enable them to work in the dry. The new foundations are first built of concrete blocks, 2′ × 1′ × 9″, laid with 6″ bond between blocks. This work is done from the centre, and where possible the inner half is excavated and underpinned, first in the hope that the excavation may tend to get

Digitized by Google

the wall back to the vertical. Above the concrete five courses of brickwork are put in just below the level of the crypt floor, and the top course is grouted with cement to the flint rubble masonry above it. Above the level of the crypt floor the old walls are built of a stone consisting chiefly of chilmack and chalk. No attempt is made to get the walls back to a vertical position before putting in the new foundations. In some places it was found necessary to place a $4' \times 4'$ brick pillar between the floor and ceiling of the crypt to assist in holding up the walls, and in such cases lengths of 10′ were underpinned at a time. Before underpinning is attempted, the walls themselves have been propped up by temporary shoring to prevent inclination. The shoring is made up chiefly of baulks of Baltic fir, 1′ square, founded on concrete blocks extending at least 18″ on every side of the timber, and with their bottom edges below the ground level to a depth of 4′ when inside the building and 3′ when outside. In some cases two shores are founded on the same block, and the block may then be as much as 9′ long. All cracks are grouted up with neat cement, and the surface is made to resemble as much as possible the surrounding stone. The building has been carefully examined for cracks, and they have all been numbered and catalogued. There are in all over 100 cracks. Cement fillets, about 1″ deep and $\frac{1}{4}$″ thick, are placed over every crack, and the dates of application are marked on them and catalogued. They are inspected every three weeks to see if settlement is still occurring, and if cracks appear, fresh test fillets are put on them, and attention is paid to the shoring and underpinning of the faulty part. The north and south walls of the nave were originally founded about 20′ down, and the buttresses along them were only founded to a depth of 6′, but as the settlement of this part is very slight, it will probably be necessary to underpin all the buttresses of the north nave and aisle and some of the buttresses of the south.

Owing to the widening of the building by the outward leaning of the walls, the roof became considerably flattened, and, as it was considered dangerous to leave it in that state, the arches had to be raised in several places in addition to the use of ties. First of all centering was placed underneath most of the ribs of the vaulting, and these ribs were raised on the centering by means of rows of small wooden wedges. Cracks were then filled in with fresh stone and cement. The ends of ribs, where roughened, were renewed. The feet of some of the ribs are tied together with 2″ iron bars. Four of these bars tie together the south wall of the south transept and the north wall of the north transept, and two of them tie together the north and south walls of the presbytery. They are also used across the lady chapel and the transepts. The repairs to the roof are not made until the walls have been underpinned and grouted, and the test cement fillets show no signs of fresh cracking.

Digitized by Google

The works have been going on during the past three years, and so far the lady chapel and presbytery have been underpinned, and the work is being continued under the transepts. Further building is necessary, as the central pillar of the three between the presbytery and feretory is built on an arch which is giving way. The concrete used in the new foundations is $4\frac{1}{2}$ to 1, and the work is so far successful that the finished foundations permitted a universal settlement of $\frac{3}{8}''$, after which no further settlement has been detected. It may be noted that although the nave shows little or no leaning east or west, the columns are inclined outwards to the north and south, although not to so great an extent as other parts of the building.

Digitized by Google

# *THE MAIN UNDERGROUND TELEGRAPH SYSTEM OF GREAT BRITAIN.*

*A Paper Contributed by* MAJOR W. A. J. O'MEARA, C.M.G., *Engineer-in-Chief British Postal Telegraphs, at the first International Conference of Telegraph and Telephone Engineers, Budapest,* 1908.

*Translated from the French.*

A CONSIDERABLE sum of money has been voted by the British Parliament in recent years in connection with the provision of underground cables for long-distance telegraph circuits, and I have thought that a short account of the underground cable scheme which the British Telegraph Administration is carrying out might be of interest to our colleagues attending the Engineering Conference at Budapest.

## EARLY HISTORY.

The first experiments with underground conductors carried out in Great Britain appear to have been made so long ago as 1816 by Sir Francis Ronalds in his garden at Hammersmith, but it was not till 1837 that subterranean wires were first utilized in London in connection with the commercial telegraph system of the country. In that year five copper wires, covered with cotton and afterwards coated with a preparation of resin, were buried between Euston Station and Camden Town—a distance of 1·2 kilomètres. A 5-needle instrument was used at this time, and consequently five wires were required to provide a single circuit. These wires were placed in grooves cut in pieces of timber, with a tongue of wood fitted over them to secure them, and it is not surprising that this experiment did not prove a success.

In the years which followed endeavours were made to produce insulated conductors suitable for subterranean work, and various descriptions of insulated conductors were laid underground in short sections in and near London. The experience thus gained and the progress made in the manufacture of insulated wire encouraged the Submarine and European Telegraph Company to lay six gutta-percha covered wires from London to Dover, through Chatham and Canterbury, distance approximately 116 kilomètres, the line being completed by the 1st November, 1852. In the following year the Electric Telegraph Company put down a line of eight underground wires on the London and North Western Railway from London to Manchester —distance 294 kilomètres—and the British Telegraph Company com-

Digitized by Google

menced to bury six gutta-percha covered wires along high roads from London to Liverpool *viâ* Birmingham and Manchester, distance 370 kilomètres, the wires to Liverpool being brought into use in 1854 and those to Manchester a year earlier.

This underground system was also extended to Scotland by means of a line of 10 wires in troughs laid as far as Glasgow, and in Ireland, Belfast and Dublin, the two principal towns, were similarly linked together.

Unfortunately, all the underground wires laid from London to the provinces failed, and were in consequence condemned in 1857–8, after a very short life. These failures appear to have put a considerable check on the development of long-distance underground circuits in our country, and the matter does not appear to have been taken up again until 1870, in which year an underground line was provided between Liverpool and Manchester—distance 57 kilomètres.

In 1870 the British Telegraph System was acquired by the State. From an early date of State ownership the serious inconveniences arising from the interruptions caused to the telegraphic service by the storms which periodically visit our shores was forced on the attention of the Telegraph Administration, but it was not found possible to undertake the provision of long-distance underground lines out of the moneys voted annually for the telegraph services, as the demand for the general extension of the telegraph system was being much pressed for by the public at that time.

On the occurrence of each serious interruption caused by storms the public Press directed attention to the loss occasioned and inconvenience suffered by the public during the dislocation of the telegraphic communications, and urged the provision of underground cables in order to reduce as far as possible such disorganization and delay. An exceptionally severe snowstorm visited the British isles in October, 1881, and caused an almost total suspension of the telegraphic service, and in consequence the Postmaster-General called for a scheme for the provision of a fairly extensive underground telegraph system.

A scheme was prepared by the Engineer-in-Chief of the Post Office in 1881, involving cables from London to Penzance, in Cornwall—distance 510 kilomètres, London to Aberdeen, in Scotland—distance 803 kilomètres, and also providing connecting links between the important centres of Ireland. The number of conductors which it was proposed should be provided in each section is shown on the map. This scheme involved the provision of 65,000 kilomètres of subterranean wire at an estimated cost of £1,720,320. After careful consideration, the Postmaster-General decided that so large an expenditure could not be incurred on the telegraph system at that time, and the question remained in abeyance until 1887. In the latter year another severe storm swept over the country, and caused such

Digitized by Google

serious dislocation of telegraphic traffic that the Associated Chambers of Commerce made urgent representations to the Postmaster-General, who again caused the question of the provision of underground conductors to be referred to the Engineer-in-Chief.

Since the first scheme was drawn up fresh developments had been taking place, and new factors were introduced into the problem. The number of wires to be carried on aerial routes out of London and other large cities had increased to such an extent that it became evident that it was no longer possible to provide a sufficient number of pole lines in the localities referred to, to meet the growth of wires occasioned by the ordinary increase of traffic. The change of policy inaugurated by the introduction of the new rate of 6d. for 12 words on inland telegrams on the 1st October, 1885, further increased the difficulties in connection with provision of open routes for the additional channels required. The seriousness of the situation can be understood when the fact is stated that the introduction of the lower tariff increased the number of messages handled from 33,000,000, in the financial year 1884–5, to 50,000,000 in the following year.

The foregoing factors were taken into consideration in connection with the proposals put forward in 1887, and provision was made for an increase in the number of telegraph circuits between important towns proposed in the 1881 scheme. In consequence, the new scheme involved the provision of 101,500 kilomètres of underground wire at an estimated cost of £2,480,000. It was again considered that the expenditure of so large a sum of money was out of the question, and no action was taken.

The growth of the telegraph system continued, and in 1895 the British Post Office purchased the telephone trunk lines of the country, which had been built by private enterprise. The difficulty of providing open routes for the additional telephone trunk circuits required to meet the increasing traffic now began to be acutely felt, and attention was once more drawn to the question of the provision of underground cables for long-distance telegraph circuits. Accordingly, in 1896, the Postmaster-General obtained a grant of £165,000 for the provision of an underground telegraph cable between London and Birmingham, a distance of 188 kilomètres. It was decided that the cable for this work should be of the paper-insulated lead-sheathed type, a type which had not up to that time been much used in this country.

In the years which have followed since 1896 further grants have been obtained from Parliament, and in consequence many important centres in Great Britain have already been connected by means of underground telegraph circuits, provided wholly in lead-sheathed cables. A schedule is included (Appendix I.) showing the total cost and the cost per mile of the principal long-distance cables laid since 1896, the routes of these cables and those which it is now proposed to lay being shown on Map I.

Digitized by Google

MAP 1.—*The System of Underground Telegraphs either existing or under construction in the British Isles in* 1908.

*The figures show the number of wires in each section.*

Digitized by Google

## Survey of Routes.

The construction of telegraph works on public highways is, in our country, regulated by various Acts of Parliament, which lay down the procedure to be followed in dealing with the local authorities responsible for the maintenance of these highways. These Acts also legislate for the manner in which cases in dispute, between the Postmaster-General and the local authorities, shall be tried in the event of a failure on the part of the two parties to come to an amicable understanding. Briefly, the Telegraph Acts provide that, in respect of roads situated in urban areas, the permission of the local authority shall be obtained to lay the pipes, which it is required to use, in positions to be agreed upon, but in respect of roads situated in rural districts such permission is not necessary. In the latter case the Postmaster-General is required to serve a notice of his intention to lay pipes, etc., but before any work can be commenced it is necessary to come to an agreement with the local authority as to the depth, course, and position of the pipes and cables to be buried. It naturally follows that at times, before the exact route and particulars of a telegraph line can be determined, negotiations have to take place with the local authorities, as the proposals of the Telegraph Engineers are not always acceptable, and the local authorities occasionally attempt to impose conditions in connection with the execution of the work to which the Postmaster-General cannot agree. For instance, the local authorities at times desire a longer route to be adopted than the one proposed, and sometimes request that the pipes shall be buried at a greater depth than that desired by the Telegraph Engineers. Further, it is not unusual for onerous conditions to be proposed in connection with the restoration of the road surface, and when the local authority undertakes to make good the surface of the road by its own workmen, it is sometimes necessary to challenge the prices which it is proposed to charge for such work. These matters frequently involve a considerable amount of correspondence and delay. Sometimes it becomes necessary to decide that the works shall be commenced before all particulars concerning the whole route have been settled, and in such cases a gap, which has to be bridged at a later period, is left in the disputed section. Difficulties of this kind had to be overcome in connection with the works dealt with in this Paper, but as they have only a local importance, I do not propose to make any further reference to the matter.

After the details in connection with the exact route to be followed, have been settled as far as practicable by the Engineers with the local authorities, schedules giving particulars of the route, mileage of each kind of road surface under which pipes will be buried, etc., are prepared, and submitted to the Engineer-in-Chief.

Digitized by Google

## PIPE LAYING BY CONTRACTORS.

All large works in connection with pipe laying, are carried out for the British Post Office by contractors. The contractors excavate the trenches, joint and lay the pipes, fill in the trenches, and are required to make good the surface of the metalled or paved roadways and foot-paths in those cases where the local authority does not elect to act as contractor to the Post Office for such work. For the purpose of inviting tenders it has been found convenient to divide the route to be followed by the pipes, into sections each about 16 kilomètres long, the boundaries of towns and villages being adopted as suitable dividing points. Invitations to tender are issued to selected contractors only, who are furnished with the particulars contained in the schedules compiled by the Engineers (to which reference has been made), in order to assist them in quoting prices for excavations in different kinds of soil, and for the restoration of the various descriptions of road surface, etc. A contractor may, of course, tender for and obtain the contract for one or more of the 16-kilomètre sections of pipe track. The contractors, whose tenders are accepted, have to undertake the responsibility for the maintenance of the road surface in good order to the satisfaction of the local authority, for six months after the date of the completion of the work. This provision is stipulated in the contract owing to the fact that the Telegraph Acts have placed this responsibility on the Postmaster-General.

In the case of the underground line between London and Birmingham which was commenced in January, 1897, the contractors were invited to supply as well as to lay the pipes. It was naturally necessary to ensure that the pipes were good, sound, of full gauge, and free from projections on the inner surface; with this object in view they were examined on delivery at the site of the work. This examination had to be carried out very strictly, and much inconvenience was caused by the fact that nearly 30 per cent. of the pipes had to be rejected as unsuitable. Largely owing to this experience, the British Telegraph Administration now purchases all pipes required for underground cables direct from the makers, and employs officers to examine the pipes at the foundries, where those found satisfactory are marked on the flat face of the socket with two arrows, so as to be easily identified. Pipes which are bent to the extent of more than 2·5 cms. in a length of 2·7 mètres length or 1·8 cms. in a length of 1·8 mètres are rejected.

A schedule (Appendix II.), which gives particulars of the works carried out since 1896, shows that cast-iron pipes having internal diameters of 5 cms., 7·5 cms., 8 cms., and 10 cms. have been used in carrying out the scheme represented in Map I., whilst the following Table states the maximum diameter of cable which can be drawn into these pipes:--

Digitized by Google

## CAST-IRON PIPES.

*Table of Standard Sizes and Weights.*

| Minimum Internal Diameter. | Lay (Length exclusive of Socket). | Minimum Weight. | Maximum Diameter of Cable that can be drawn in. |
|---|---|---|---|
| Centimètres. | Mètres. | Kilogrammes. | Centimètres. |
| 5 | 1·8 | 19·3 | 4·375 |
| 7·5 | 2·7 | 47·2 | 6·875 |
| 8 | 2·7 | 51·7 | 7·5 |
| 10 | 2·7 | 74·7 | 9·375 |

Pipes of the smallest diameter mentioned have been used only on those branch lines where it is known that a comparatively small number of conductors will be required. Pipes having a diameter of 7·5 cms. were for many years almost exclusively employed on all our important works, but in connection with the development of the main underground system it has been found advisable to make provision for a certain number of conductors for telephone trunk purposes. In order that the electrostatic capacity of the conductors required for telephone purposes may be kept low without diminishing the number of conductors hitherto provided in main cables, it has recently been decided to use pipes 8 cms. in diameter on the principal long-distance underground routes. Pipes of 10-cm. diameter have been used in a few exceptional cases when very long-distance telephone trunk lines are involved, again with the main object of reducing the electrostatic capacity of the conductors.

At the time when the first long-distance underground cable was laid, it was considered that it would not be advisable to attempt to draw into pipes lengths of lead-sheathed cable longer than 137 mètres, and this circumstance naturally determined the normal length of the pipe sections, *i.e.*, the distance between the centres of two consecutive cable joints. When the cable was extended northward from Birmingham, the length of 137 mètres was adhered to as far as Carlisle. It was naturally recognized that the cable joints were the weak points in the system, and the question of reducing the number of joints was reconsidered when the latter place was reached. Experience had shown that cables on drums, the total weight of which did not exceed 3,600 kilogrammes, could be conveniently transported by rail and road, and did not offer any difficulty in handling in connection with cable operations. Since it was ascertained that the weight of the cable, designed to bridge the distance between Carlisle and Glasgow, was such that a length of 201 mètres of the same, together with its

Digitized by Google

drum, would not exceed 3,600 kilogrammes, the length of the pipe sections north of Carlisle was increased from 137 mètres to 201 mètres. More recently the tenth part of an English mile has been adopted as a convenient length for pipe sections where 8-cm. pipes are used. In the case of 10-cm. pipe lines the length of the sections is 108 mètres.

Wherever possible, pipes have been laid under recognized footpaths, or under the roadside wastes and grass margins, metalled and paved portions of roadways being avoided as far as possible. The trenches are of such depth as to provide a covering of 35 cms. measured from the upper side of pipes laid under footpaths, and a covering of 60 cms. similarly measured where pipes are under grass margins or metalled roadways.

The actual methods employed in laying the pipes do not call for special comment. Every precaution is naturally taken to ensure the inner surface of the pipe line when laid being perfectly smooth, so that no injury may result to the lead sheath during the process of drawing the cable into the pipes. For this reason, and to ensure that all the pipes are of the requisite diameter to admit the type of cable which it is proposed to draw in, an iron mandrel, 3 millimètres less in diameter than the specified minimum diameter of the pipe, is drawn through the completed section of pipe work, and any obstruction or irregularity discovered is rectified.

Taper plugs of hard wood are inserted into each end of every pipe section on its completion, to prevent the entry of soil, etc., into the pipes. These plugs are well soaked in water before being inserted into the pipes, so as to provide against the pipes being split by the swelling of the plugs should the soil become water-logged after heavy rains or floods. At the positions where the cable joints will occur gaps are left in the pipe work; the length of these gaps varies from 1·25 to 1·5 mètres, and is determined by the character of the protection to be provided for the cable joint in each particular case.

As the work progressed a sketch of the route was prepared, giving landmarks and measurements, and at every joint opening an oak stake, branded with the distance from the opening, was driven into the hedge bank to act as a temporary marking post.

The rate at which the pipe laying proceeded under each contract varied considerably. On some of the more recent works, pipes have been laid at the rate of about 11 kilomètres per month, but 8 kilomètres per month is considered to be good progress under one contract.

The prices at which the pipe laying has been carried out by contractors has naturally varied according to the locality and to the nature of the soil which has had to be excavated. I have thought that it would be a matter of interest to you to have some information on this subject, and I accordingly include a schedule (Appendix III.)

Digitized by Google

giving the prices paid for trenching and pipe jointing in the case of some of our more recent works, and separately the cost of the reinstatement of metalled and paved roadways.

## Joint Boxes and Test Boxes.

Three methods have been adopted for protecting cable joints on the main underground routes, viz. :—

1. Joint boxes.
2. C.I. flanged couplings with groove.
3. C.I. solid slides.

Joint boxes are employed at points where cable joints fitted with air-nozzles have to be made under pavings which it would be costly to disturb when access to the cable is required. I have included drawings showing two of the types of joint boxes generally used. In *Fig.* 1 is shown the extra large joint box used under normal circumstances, and in *Fig.* 2 the double junction which is used at sharp angles and also when the pipes have to be buried at a depth greater than 45 cms. The "terminating pipes" shown in the drawing are to accommodate the lead joint sleeve whilst the conductors are being jointed, and thus enable the dimensions of the boxes to be reduced to a minimum.

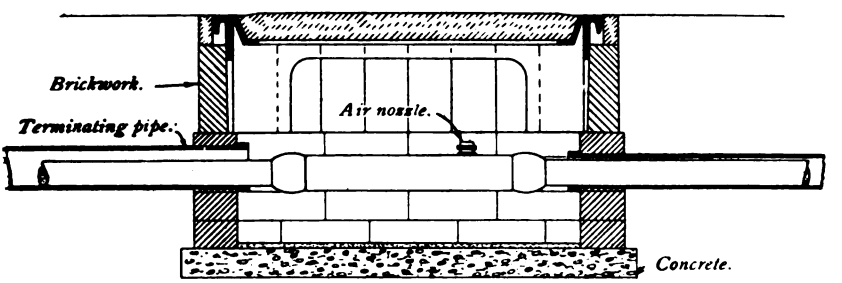



Fig. 1.—*Extra large Joint Box with Terminating Pipe.*

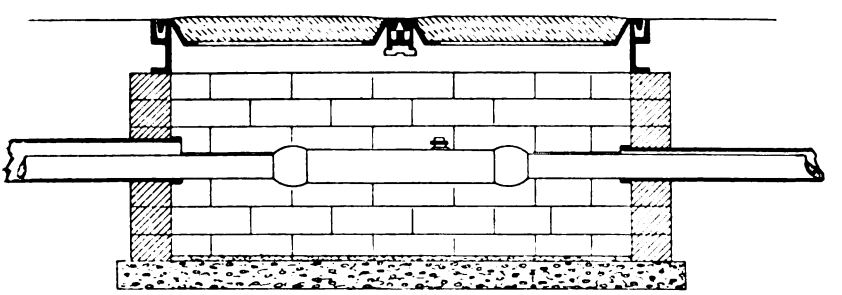


Fig. 2.—*Double Junction Box.*

Digitized by Google

The C.I. flanged coupling with groove is employed at points where the cable joints are provided with air nozzles, and can be conveniently buried under light soil, involving small cost for excavation and reinstatement, the C.I. solid slides being employed under similar conditions at cable joints where no provision is made for desiccating the cable. The usual practice is to provide an air nozzle at every fifth joint of the cable.

At intervals of approximately 8 kilomètres pillar test boxes are fixed, into which cable connection boxes are fitted. The cable conductors are led into these cable connection boxes, which form convenient points for making all ordinary electrical tests, and also facilitate the air drying of the cable should moisture obtain access to the paper and lower the insulation of the conductors.

## WORK PARTIES.

Some parts of the country traversed by the pipe tracks are very sparsely populated, so that the men employed by the contractors had to be accommodated in tents, and occasionally it was found difficult to keep the men together. For instance, whilst work was in progress in Scotland, the numbers of men employed daily on a particular section of the work varied from 15 to 40 men.

Each contractor's gang was closely supervised by a clerk of works, on behalf of the Post Office. The duty of this man was to see that the conditions of contract were strictly adhered to, and also that the pipes were set in the proper alignment, especially round curves in the road. He also took note of all deviations from the contract, such as extra depth, concreting over pipes where they had to be brought near the surface, etc. The clerks of works were frequently visited by the Engineer, to whom all matters were reported. The checks employed made it possible to certify the contractors' accounts promptly, as all particulars relating to extras were always recorded up to date.

At the time that the underground works were first commenced it was felt that, as the security of the telegraphic communications depended in such a large measure on the uninterrupted use of the long-distance underground circuits, too much care could not be bestowed on the operations in connection with the laying and jointing of the cables. It would have been very unsatisfactory to entrust this class of work to men in the employ of contractors, whose employment with the Post Office Engineering Department could only be of a very temporary nature. In consequence it was decided that all the work in connection with cable laying and jointing should be executed by workmen in the direct employ of the Postmaster-General. The advantages arising from the adoption of this course will be evident when it is realized that the services of the

Digitized by Google

men thus employed have been practically permanent with the Telegraph Administration since the commencement of the work. Further, the freedom from interruption arising from faults due to bad workmanship, to which a reference will be made later, may in a large measure be traced to the procedure adopted.

It has been already stated that along some parts of the route the contractor's men engaged on pipe laying had to be housed in tents. This was also the case with the men engaged by the department in connection with cabling operations. Tents and other articles of camp equipment were obtained on loan from the War Department, and camps were formed and arrangements for cooking food were made by the Telegraph Administration free of cost to the men employed.

## Types of Cable.

As might be expected, our administration has not adhered to the type of cable which was laid over the first section of the northern route, but we have continually endeavoured to effect improvements in the type of cable as the system has been extended. This is exemplified by the fact that no less than three different cables have been used on the main line to the north, London to Glasgow, a total distance of 650 kilomètres, with a total length of wire of nearly 60,000 kilomètres.

The first type of cable was laid between the years 1897 and 1900, and is 187·6 kilomètres in length. The conductors, which are 76 in number, are laid up in quadruple form for a distance of 48 kilomètres, and for the remainder of the distance are in twisted pair formation. Electrical and other data relative to this cable are as follows :—

| | |
|---|---|
| Weight of conductor per kilomètre ... ... | 68 kgs. |
| Resistance ... ... ... ... ... | 3·638 ohms. |
| Wire-to-wire electrostatic capacity ... ... | ·042 mfd. |
| Thickness of insulating paper ... ... ... | ·0635 mm. |
| Thickness of lead sheath ... ... ... | 4·06 mms. |
| External diameter of cable ... ... ... | 6·667 cms. |

In the interval between the laying of the first and second cables the type of cable for long underground circuits had undergone considerable change. The second section of cable consists of 103 conductors, 74 of them being laid up in twin formation, the remaining 29 being single conductors, paper insulated, and served with a spiral wrapping of soft copper foil round each conductor. The copper foil is ·076 mm. thick and 7·62 mms. wide, and is taped with an overlap of 30 per cent.

The wrappings of copper foil round the several conductors are in contact with each other, and are also in contact with the lead sheath

Digitized by Google

of the cable, as they form the external layer of conductors in the cable. Each conductor so treated is thus surrounded by an earthed screen, which completely shields it from the electrostatic action of currents rapidly rising and falling in neighbouring conductors. To some extent the copper foil acts also as an electro-magnetic screen, and the conductors, though adjacent in the cable, are nevertheless capable of working over long distances without appreciable mutual inductive interference. The 74 wires laid up in twisted pairs form the central portion of the cable, the screened wires surrounding them. They are arranged so that different "lays" or lengths of twist are given to the groups of pairs in the several layers. This procedure prevents the mutual interference which would take place if pairs of the same length of lay were revolved together.

Particulars of the second section of cable, which is 128 kms. in length, are as follows :—

| | |
|---|---|
| (*a*). Weight of screened conductors per km.... | 31·78 kgs. |
| (*b*). Weight of twin conductors per km. ... | 45·4 „ |
| Resistance of (*a*) per km.... ... | 7·796 ohms. |
| Capacity of (*a*) „ „ ... ... | ·09 mfd. (wire to earth). |
| Resistance of (*b*) per km.... ... | 5·457 ohms. |
| Capacity of (*b*) „ „ ... ... | ·04 mfd. (wire to wire). |

The thickness of the paper insulation is ·063 mm. and that of the lead sheath 3·94 mms., the external diameter of the cable being 6·854 cms. The weight of the copper foil is approximately equal to the conductor which it encloses.

The third cable marks a still further development in trunk cable manufacture. In this case the inner or central portion of the cable consists of 68 wires, twisted in pairs. Surrounding these are 29 screened conductors. The characteristic of this type of cable lies in the peculiar method adopted in twinning the groups of pairs. Of the 68 conductors, 56 are formed into seven groups, each group consisting of eight wires. The method known as successive twinning is adopted, that is, two twisted pairs are twisted together to form a 4-wire group or core, and two such groups are twisted together to form an 8-wire group or core. The seven groups thus formed are arranged with one group in the centre, surrounded by the remaining six groups. In each of the six spaces between these six 8-wire groups and the outer layer of 29 screened conductors is placed a twisted pair of conductors. These are known as worming pairs. The complete cable thus consists of one 8-wire multiple-twin core as a centre with six similar cores surrounding it, then six twisted pairs, and finally 29 screened conductors.

Digitized by Google

Particulars of this cable, which is 335 kms. long, are as follows :—

| | | |
|---|---|---|
| (*a*). | Weight of conductors in the 8-wire cores per km. ... ... ... ... | 45·4 kgs. |
| (*b*). | Weight of worming conductors per km. ... | 68 „ |
| (*c*). | Weight of screened conductors per km. ... | 31·78 „ |
| (*d*). | Resistance of (*a*) per km. ... ... ... | 5·457 ohms. |
| | Capacity „ „ „ ... ... ... | ·040 mfd. (wire to wire). |
| (*e*). | Resistance of (*b*) per km. ... ... ... | 3·638 ohms. |
| | Capacity „ „ „ ... ... ... | ·040 mfd. (wire to wire). |
| (*f*) | Resistance of (*c*) per km. ... ... ... | 7·796 ohms. |
| | Capacity „ „ „ ... ... ... | ·090 mfd. (wire to earth). |

The thickness of the paper insulation is the same as in the two previous cables, and that of the lead sheath 3·81 mms., the external diameter of the cable being 6·858 cms.

*Fig.* 3 gives a diagrammatic representation of the cable.

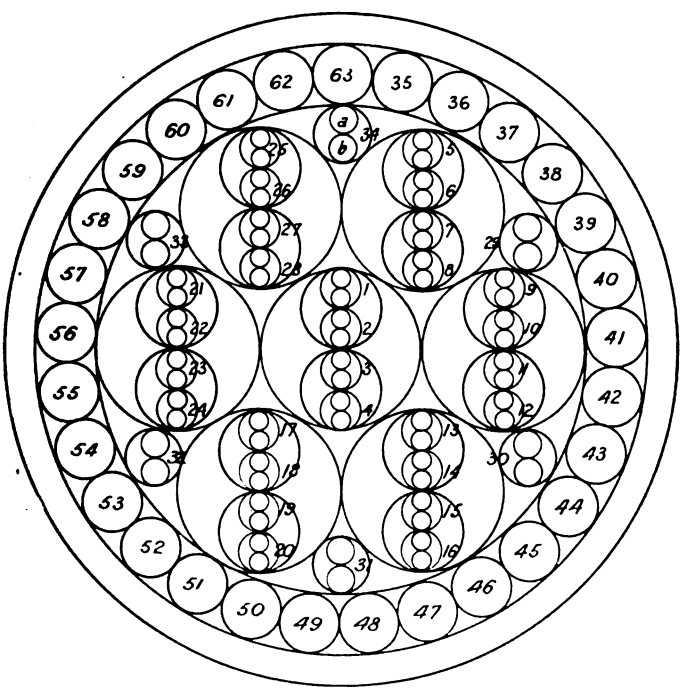



FIG. 3.—*Diagram of Multiple Cable, showing the Numbering as viewed from the London Side.*

The object of multiple twinning is to secure that conductors may when necessary be bunched, that is, joined in parallel to any desired

Digitized by Google

extent. By this means circuits of great conductance are obtained without anything like a proportional increase in the electrostatic capacity. For instance, an 8-wire core will furnish four loops with conductors of 45·4 kgs., two loops of 90·8 kgs., or one loop of 181·6 kgs. The loop or loops thus formed will furnish a pair, or pairs, of twisted conductors, and so possess the advantage of freedom from inductive disturbance. The system also admits of the provision of additional circuits by superimposing upon the twisted pairs, whether of single loops or bunched loops. A further reference will be made to this.

The completion of the Northern Underground system between London and Glasgow may be regarded as the first step in our programme for the provision of an underground cable system. The second step was the laying of a cable through the West and South West of England. This is known as the Western Cable, and connects up London, Bristol, Exeter, Plymouth, and Penzance, a total distance of 532·8 kilomètres. The work has been in progress for the past two years, and the cable has now been laid between London and Bristol, a distance of 192 kilomètres. The type of cable adopted for this route deserves some notice, as it is different from either of the four sections yet described.

It is obvious that upon a route which passes through many large cities, and through areas which are widely different in character and in local telegraph traffic requirements, the number of wires will necessarily not be the same throughout. For instance, the number of conductors required in the remoter sections will naturally be less than in the sections nearer London. Between London and Reading, a distance of 67·2 kilomètres, 169 conductors are provided in the cable; this number drops to 104 to Bath, which is 109 kilomètres farther on. Between Bath and Bristol, a distance of 19 kilomètres, the circuit requirements increase considerably, and the cable contains 162 conductors. Beyond this, to the extreme end of the cable, the number of conductors will be less. It should be observed, however, that notwithstanding this fact, the type of cable is uniform throughout, the only difference being in the number of conductors. The cable is of a composite order, as is the third section of the Northern Underground Cable just described, but there is this important difference, that in addition to ordinary twinned pairs of conductors and single-screened conductors there are a number of groups composed of four twisted pairs, forming quadruple cores of eight wires each. The essential difference between this arrangement and the multiple twin core is that, in the latter, two groups of two twisted pairs (eight conductors) are twisted together in the manner already described, whereas, with the quadruple-pair core, the four twisted pairs are all twisted together in quadruple form. The arrangement can perhaps be gathered by referring to *Fig.* 4, which shows, diagram-

Digitized by Google

matically, the actual cable laid in the section between Reading and Bath, a distance of 108·8 kilomètres.

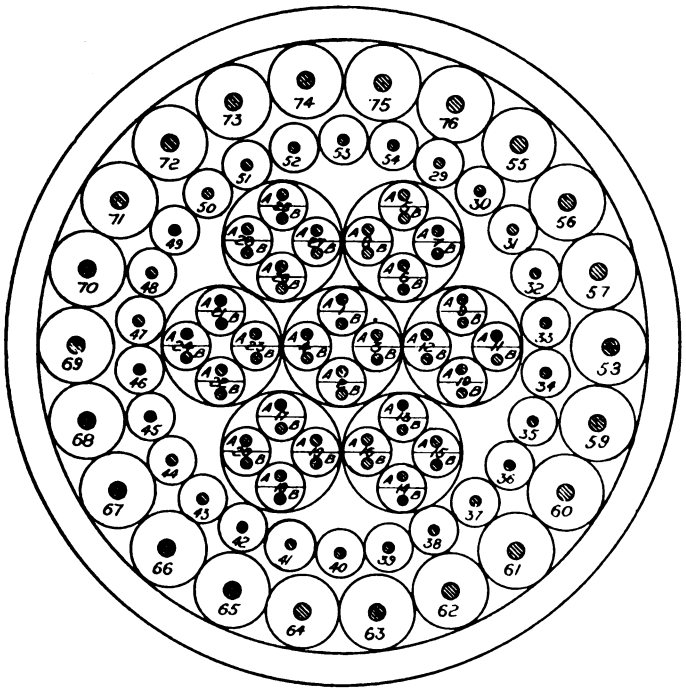



FIG. 4.—*Diagram of Quadruple Pair Cable.*

It will be observed that the more central portion of the cable consists of seven complete quadruple core groups, each group comprising four twisted pairs. Surrounding these are 26 single copper-screened conductors, and in the outer layer are shown 22 screened conductors. Further particulars of the cable are as follows:—

| | |
|---|---|
| (*a*). Weight per kilomètre of Q.P. conductors... | 45·4 kgs. |
| (*b*). Weight per kilomètre of inner layer of screened conductors ... ... ... | 31·78 „ |
| (*c*). Weight per kilomètre of outer layer of screened conductors ... ... ... | 90·8 „ |
| Resistance per km. of (*a*) ... ... ... | 5·457 ohms. |
| Capacity „ „ „ ... ... ... | ·04 mfd. (wire to wire). |
| Resistance per km. of (*b*) ... ... ... | 7·796 ohms. |
| Capacity „ „ „ ... ... ... | ·09 mfd. (wire to earth). |
| Resistance per km. of (*c*) ... ... ... | 2·728 ohms. |
| Capacity „ „ „ ... ... ... | ·09 mfd. (wire to earth). |

Digitized by Google

The thickness of the paper insulation is ·063 mm., and that of the cable sheath 3·81 mms. The external diameter of the cable is 7·4168 cms.

It should be mentioned that in the case of screened conductors three layers, as a minimum, of insulating paper are required, the first of which is longitudinally and the others spirally wrapped.

The advantages to be secured by the quadruple-pair type of cable are somewhat similar to those offered by the multiple twin. Diagonal pairs in the same quadruple core can be bunched in order to secure ncreased conductance without a proportional increase in the electrostatic capacity. The provision of additional circuits by superimposing on the loops is also a feature of the cable. In the multiple-twin type of cable the method of successive twinning admits of the bunching of pairs to a greater degree than the quadruple-pair cable; but in actual practice the quadruple-pair type of cable has satisfactorily fulfilled the requirements of bunching.

## TESTING OF PAPER-INSULATED CABLES AT MANUFACTURERS' WORKS.

Paper-insulated cables are subject to the following tests at the manufacturers' works by officers of my department prior to being delivered:—

(*a*). For insulation, resistance, and contact.
(*b*). For electrostatic capacity between each wire and earth and between the wires of each pair.
(*c*). For conductor resistance.
(*d*). To check the relative positions of the wires in the cable.
(*e*). To ensure that the lead sheath is free from defects.
And finally, the insulating paper is tested for strength before and after drying.

(*a*) and (*b*). As it is necessary to ascertain the insulation of each wire from every other wire of the cable, all the wires which cannot possibly touch each other are grouped together and tested for insulation resistance and wire-to-earth capacity, the remaining wires of the cable being joined to the lead sheath and earthed. The wires forming the cable are divided into as small a number of such groups as is possible, and each group tested with all the other groups earthed. The capacity between the wires of a pair is tested by removing the earth connections from cable and battery.

The average insulation resistance and capacity per mile of wire is then calculated.

A battery of 600 volts is used for the insulation test and one of about 60 volts for the capacity test.

Digitized by Google

(*c*). The conductor resistance is measured by means of the Wheatstone Bridge. In making this test all conductors of the same gauge are connected in series, and the average resistance per mile of wire at 60° Fahr. is calculated. This test shows whether there are any broken conductors.

(*d*). This test is taken in order to ascertain whether the wires occupy the same relative positions at each end of the cable, and to ensure that they are in proper sequence. This is done by ringing a bell through each pair, and noting that the pairs are in the specified order. The test is necessary, as pairs sometimes cross one another during manufacture.

(*e*). The lead sheath is submitted to an internal air pressure of 75 lbs. per square inch, and immersed in water for 24 hours to ensure that it is free from defects.

## Transport of Cable.

The transport to the site of the work of the whole of the pipes, cables, and other material employed in connection with these works has been carried out under local contracts. At the time the main underground works from London to Birmingham were started only horse transport was available, but when the new type of road motor vehicles began to be employed for trade purposes in this country some five years ago, it was decided to invite tenders for the haulage of cables and other materials from railway stations to the points at which they would be used by this means.

When the question was first considered in connection with a hilly section of the Northern Cable it was found that there was a considerable saving in favour of steam traction, and consequently this means was more extensively used afterwards, not only for cable drums, but for all classes of heavy line stores. Later it was calculated that the average cost of steam haulage in the districts where it was used was 73½ per cent. of the estimated cost of the same work if done by horse haulage, whilst the average time occupied was only 31 per cent. Steam traction proved especially advantageous and economical in those cases where the stores had to be conveyed over hilly roads.

The experience gained by our administration has resulted in considerable saving being effected as the works have proceeded. In many cases it has been found more economical to accept the maker's quotation for delivery of cables, etc., at their works, and to make separate provision for transport of the cable to the scene of the work.

The conditions in the districts near London differ largely from those in outlying districts. Cable drums cannot be delivered in bulk and left lying by the roadside until required, as is the case in country districts when large quantities of drums are delivered at one time by mechanical traction. For this reason, and as contractors have usually

Digitized by Google

to guarantee a delivery of only three drums per day, which is sufficient to keep a cabling gang employed, it has not always been found desirable to accept the quotation for mechanical traction in favour of horse traction on account of speed, and consequently the lowest quotation, whether for horse or mechanical traction, is usually accepted. When the question of the amount of cable which can be delivered in a given time becomes a matter of sufficient importance and when the route in question is hilly, mechanical transport undoubtedly possesses advantages. This was proved in connection with a certain section of the Northern Cable, when the cable required was delivered at the rate of from 8 to 12 drums per diem by mechanical transport, the empty drums being picked up on the return journey at the same time. Such a rate of delivery would have been more difficult to obtain, and certainly more costly, if horse haulage had been resorted to.

The following Tables give a general comparison between the cost of conveying cable—(I.), by means of horse and steam traction; (II.), by rail and sea :—

I.

| Method of Traction. | Average Weight per **Mile** Kilomètre of Cable. | Weight of Drum. | Number of Drums per **Mile** Kilomètre of Cable. | Number of Drums per Journey. | **Average** Rate per Drum. |
|---|---|---|---|---|---|
| | Tonnes. **Tons.** | Tonnes. **Cwts.** | | | Francs. **£ s. d.** |
| Horse ... ... ... | **24** 15·24 | **10** ·5 | **8** 5 | 1 | **1 6 2** 32·7 |
| Mechanical ... ... | **24** 15·24 | **10** ·5 | **8** 5 | 5 | **16 9** 20·9 |

Figures in block type show English equivalents.

Digitized by Google

II.

*Comparative Statement of the Cost of Conveyance of Cable by Rail and Sea.*

| Destination. | Length of Cable. | Total Number of Drums. | Average Number of Drums per Trip. | Weight. | Rate by Sea. Owners' Risk. | Rate by Rail. Carriers' Risk.* | Amount Paid for Conveyance by Sea. | Cost had Cables been sent by Rail.* | Average Cost per Drum conveyed by Sea. | Average Cost per Drum for Conveyance by Rail. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Kilomètres. **Miles.** | | | Tonnes. **Tons.** | Per Tonne. Francs. s. d. | Per Tonne. Francs. s. d. | Francs. £ | Francs. £ | Francs. £ s. d. | Francs. £ s. d. | |
| London to Glasgow (90 hours' voyage). | **10m. 467y.** 16·4 | 85 | 14 | **255½** 260 | **30 7** 37·1 | **51 8** 63·5 | **386** 9650 | **660** 16500 | **4 11 0** 113·5 | **7 15 0** 194·1 | * There are no owners' risk rates for cable consigned from London to the places mentioned. |
| London to Glasgow† (90 hours' voyage). | **23m. 264y.** 37 | 187 | 10 | **551¼** 562 | **32 9** 40·5 | **51 8** 63·3 | **912** 22800 | **1424** 35600 | **4 17 0** 121·9 | **7 12 0** 190·4 | † The cable in this instance was obtained from a different manufacturer than that in the first instance. |
| Liverpool to Chatham (72 hours' voyage). | **16m. 832y.** 26·4 | 215 | 15 | **483½** 493 | **27 0** 33·4 | **44 0** 54 | **659** 16475 | **1066** 26650 | **3 1 0** 76·6 | **4 19 0** 123·9 | |

Figures in block type show English equivalents.

Digitized by Google

In the early stages of these subterranean works it was considered that there would be some advantage in the telegraph administration possessing suitable vehicles for the transport of the cable drums from the railway depôts to the site of the works. In consequence, a vehicle was specially designed for horse haulage; later, a larger vehicle of the same type was designed suitable for use with steam and petrol engines.

The bodies of these vehicles are hung very low, with a view to facilitating the unloading of the drums on the roadside. They are provided with a specially strong screw brake in addition to a shoe skid. It has not been possible always to employ the special vehicles, and frequently wagons have had to be hired for the transport of cables from railway depôts; in such cases care has been taken to select vehicles having platforms hung low, not only to avoid the risk of accidents from overturning on rough and hilly roads, but also in order to reduce the labour of unloading cable drums at the site of the work. Extemporized gyns have been employed for unloading cables when the width of the road has not been sufficient to enable the drums to be rolled down skids.

*(To be continued).*

---

## *APPENDIX I.*

*Schedule showing* (1) *Total Cost, and* (2) *Cost per Mile of Laying Main Underground Cables.*

| Route of Cable. | Length of Cable. | No. of Wires in Cable. | | Estimated Cost of Pipe Laying. | Average Cost per Mile of Pipe Laying (including Pipe). | Total Cost of Cable (including Pipe, Cable, Laying, Jointing, etc.). | Average Cost per Mile of Complete Cable. |
|---|---|---|---|---|---|---|---|
| | | Max. | Min. | | | | |
| | Miles. | | | £ | £ s. d. | £ | £ |
| Northern Cable (London to Glasgow) ... ... | 406⅔ | 103 | 76 | 123,911 | 304 14 0 | 596,852 | 1,467 |
| Western Cable (London-Tavistock section completed, Tavistock to Penzance section in hand). | 342¼ | 162 | 24 | 84,642* | 349 4 0 | 341,506† | 1,579 |
| Manchester to Leeds ... | 43½ | 64 | 64 | 18,575 | 427 0 0 | 65,159 | 1,497 |
| Newcastle to Durham ... | 14½ | 109 | 109 | 4,400 | 303 0 0 | 23,713 | 1,635 |

* Only 242¼ of pipe laid to 31st March, 1908.
† Only 210¾ miles of cable drawn in to 31st March, 1908.

Digitized by Google

## APPENDIX II.

*Schedule showing Sizes of Pipes used in Connection with the Northern and Western Cables and Time Occupied in Pipe Laying.*

| Section of Cable. From | Section of Cable. To | Length of Section | Size of Pipe. | Depth Pipe Laid Underground. | Time Pipe Laying Occupied. From | Time Pipe Laying Occupied. To |
|---|---|---|---|---|---|---|
| *Northern Cable.* | | Kilomètres. | Centimètres. | Decimètres. | | |
| General Post Office, London. | Watford ... ... | 29·60 | 7·50 | 6·00 | Feb. 97 | Aug. 97 |
| Watford ... ... | Fenny Stratford ... | 49 60 | ,, | ,, | Aug. 97 | Feb. 98 |
| Fenny Stratford ... | Leamington ... | 71·20 | ,, | ,, | Feb. 98 | Aug. 99 |
| Leamington ... | Birmingham ... | 38·00 | ,, | ,, | Aug. 99 | Mar. 00 |
| Birmingham ... | Stafford ... ... | 40·00 | ,, | ,, | July 01 | Feb. 02 |
| Stafford ... ... | Nantwich ... .. | 46·40 | ,, | ,, | June 02 | Jan. 03 |
| Nantwich ... ... | Warrington ... | 41·60 | ,, | ,, | Aug. 02 | Dec. 02 |
| Warrington ... | Wigan ... ... | 19·20 | ,, | ,, | April 03 | July 03 |
| Wigan ... ... | Preston ... ... | 28·80 | ,, | ,, | June 03 | Oct. 03 |
| Preston ... ... | Carlisle ... ... | 149·40 | ,, | 7·00 | Sept. 01 | Mar. 03 |
| Carlisle ... ... | Beattock ... ... | 46·40 | ,, | 6·00 | June 04 | Nov. 04 |
| Beattock ... ... | Abington ... ... | 30·80 | ,, | ,, | June 03 | Nov. 03* |
| Abington ... .. | Glasgow ... ... | 59·00 | ,, | ,, | July 04 | Mar. 05 |
| *Western Cable.* | | | | | | |
| General Post Office, London. | Bayswater ... | 5·60 | — | — | Existing earthenware ducts | used. |
| Bayswater ... ... | Uxbridge .. ... | 22·20 | 10·00 | 6·00 | Nov. 04 | April 05 |
| Uxbridge ... ... | Slough ... ... | 10·00 | ,, | ,, | April 05 | May 05 |
| Slough ... ... | Reading ... .. | 29·60 | ,, | ,, | Oct. 05 | Mar. 06 |
| Reading ... ... | Hungerford ... | 41·60 | 8·00 | 3·50 (8 in Reading) | May 06 | Dec. 06 |
| Hungerford ... | Bath ... ... | 66·80 | ,, | 6·00 | Nov. 06 | Mar. 07 |
| Bath ... ... | Bristol . . ... | 19·00 | 10·00 | ,, | Dec. 06 | Mar. 07 |
| Bristol ... ... | Churchill ... ... | 21·60 | 8·00 | ,, | Aug. 07 | Nov. 07 |
| Churchill ... ... | Exeter ... .. | 99·20 | ,, | ,, | June 07 | Jan. 08 |
| *Spur.* | | | | | | |
| Churchill .. .. | Weston-super-Mare | 15·20 | 5·00 | ,, | May 07 | Sept. 07 |

* This section is 300 mètres above sea level, and was much subject to storm interruptions. In consequence the work was placed in hand in advance of the other sections.

Digitized by Google

# *APPENDIX III.*

## MAIN UNDERGROUND SYSTEM.

*Statement showing (I.) Costs of Laying and Jointing one 7·5-cm. or one 8-cm. Pipe (excluding Cost of Pipe), and (II.) Average Costs of Reinstatement under Various Classes of Paving.*

| Laying and Jointing one 7·5-cm. or one 8-cm. Pipe. | Average Prices, including Filling in and Permanent Restoration of Pavement, per yard-run. [1] | Average Prices, including *Temporary* Restoration, *but excluding Permanent Restoration*, per *yard-run*. [2] | Average Prices per square yard super of Permanent Reinstatement. [3] |
|---|---|---|---|
| *Footway.* | s. d. | s. d. | s. d. |
| Cinders ... ... ... ... | 1 0 | 9 | 5½ |
| Gravel ... ... ... ... | 1 2 | 10 | 7½ |
| Cobbles ... ... ... ... | 1 9 | 11 | 1 6 |
| York stone on ashes ... ... | 2 7 | 1 1 | 1 1 |
| Flagstones ... ... ... | 2 5 | 11 | 1 4 |
| Cement slabs ... ... .. | 2 6 | 1 0 | 1 11½ |
| Tiles ... ... ... ... ... | 1 8 | 10 | 1 5 |
| Granite setts ... ... ... | 2 4 | 1 4 | 1 9 |
| Blue bricks on ashes ... .. | 2 2 | 1 5 | 1 10 |
| Ashes ... ... ... .. | 1 3 | 10 | 9 |
| Tar paving on ashes ... ... | 2 1 | 11 | 2 1 |
| Cement ... ... ... ... | 2 10 | 8 | 3 8 |
| Asphalte ... ... ... ... | 2 8 | 9 | 3 10 |
| Rock asphalte on concrete .. | 3 5 | 1 0 | — |
| Kerb ... ... ... ... | 2 0 | 1 1 | 6 |
| *Roadway.* | | | |
| Granite setts on concrete ... | 6 1[4] | 1 10[4] | 4 6 |
| Granite setts not on concrete .. | 3 2 | 2 2 | 1 10 |
| Gravel or flint ... ... ... | 1 6 | 11 | 1 1 |
| Macadam ... ... ... | 1 6 | 10 | 1 5 |
| Cobbles ... .. ... .. | 2 5 | 1 5 | 2 0 |
| Cinders ... ... ... ... | 1 1 | 10 | — |
| Grass Margin ... ... ... | 10 | 8 | 6 |

[1] The contractors' charges include excavation of trench; removal of obstruction; carting excess rubbish to shoot; cartage of pipes; levelling and punning bed for pipes; laying and jointing pipes (providing lead and yarn); fill in, pun, and level; permanent reinstatement of pavings, including six months' maintenance to satisfaction of local authority.

[2] Contractors' charges include excavation of trenches; removal of obstructions; carting excess rubbish to shoot; cartage of pipes; laying and jointing pipes (providing lead and yarn); fill in, pun, and level; temporary reinstatement of pavings; lighting, watching, and guarding where necessary.

[3] 45 per cent. is the average percentage increase for work in London.

[4] Prices vary according to depth of concrete.

Digitized by Google

# *THE R.E. HEADQUARTER MESS.*

## (*Continued*).*

*By* Lieut.-Colonel B. R. Ward, R.E.

In addition to the portraits, the Mess possesses busts of eight celebrated men. Seven of these busts are in the north annexe; the eighth—that of Vauban—is in the whist room, on the first floor.

Two of the busts—those of Sir John Jones and Sir John Burgoyne—have been already alluded to. The remaining busts in the north annexe represent Capt. Thomas Drummond, Sir Arthur Cotton, Sir Andrew Clarke, General Gordon, and Sir Richard Harrison.

The bust of Drummond, which is of colossal proportions, bears the following inscription :—

Captain Thomas Drummond, R.E.
2nd Lieut., March, 1816.
2nd Captain, August, 1837.
Private Secretary to Chancellor of Exchequer, 1833.
Under-Secretary for Ireland, 1835.
Commissioner, Irish Railways, 1836.
Died 15th April, 1840.

The foregoing inscription gives some indication of the wonderful political and administrative aptitude of this young Engineer officer, whose death at the age of 43 was regarded as a national calamity throughout the length and breadth of Ireland. The bust, copied from Hogan's statue erected in Dublin by public subscription in 1843, shows the features of a man not unlike the younger Pitt or Joseph Chamberlain, and evidently endowed with the highest intelligence and force of character.

Few men have crowded into the short space of 43 years so full a record of scientific work and political achievement. His inventions include first the "Drummond light," in which a block of lime was raised to the highest possible temperature by means of the oxy-hydrogen blast; and, secondly, the Colby-Drummond compensation bars for accurate survey measurements.

The "Drummond light" is still in every-day use in the form of the Welsbach incandescent mantle, and it was by far the most powerful

Digitized by Google

illuminant known until the advent of the electric arc. Sir John Herschel thus describes the impression produced when the light was first exhibited in the Tower :—"The common Argand burner and parabolic reflector of a British lighthouse were first exhibited, the room being darkened, and with considerable effect. Fresnel's superb lamp was next disclosed, at whose superior effect the others seemed to dwindle, and showed in a manner quite subordinate. But when the gas began to play, the lime being brought now to its full ignition and the screen suddenly removed, a glare shone forth, overpowering, and as it were annihilating, both its predecessors which appeared by its side, the one as a feeble gleam, which it required attention to see, the other like a mere plate of heated metal. A shout of triumph and of admiration burst from all present."*

The Colby-Drummond compensation bars were used in measuring the famous Loch Foyle base line—the most accurately measured base line in the world, according to Sir John Herschel. At this time Drummond was engaged on the Irish survey, under Lieut.-Colonel Colby. The survey was carried out by means of three companies of Sappers and Miners, specially trained in survey duties. It was commenced in 1825, and the first sheets, representing the County of Londonderry, were published in 1833. For scientific accuracy, combined with utilitarian and economic results, the work was one of the most striking ever accomplished by the Corps (see *Dictionary of National Biography*, Art., Colby-Thomas, Vol. XI., p. 258).

About 1831 Drummond glided into politics, and great as were his achievements in science, they are overshadowed by the greatness of his political work.

He was appointed Under-Secretary at Dublin Castle in 1835 at a time when Ireland was seething with political agitation, social disorder, and religious feuds. So terrible was the state of anarchy and disorganization in the country, that O'Connel loudly demanded the repeal of the Union as the only remedy for its ills. But Drummond was equal to the situation. "While engaged on the Ordnance Survey he had studied the Irish question on the spot. He was moved by the miseries of the people, touched by the injustice to which they were subjected, and pained by the evidence of misrule which everywhere met his eye. Ireland became to him a second fatherland, and he entered upon his labours full of zeal for the national welfare and determined to administer the law with even-handed justice." †

The most striking monument of his work in Ireland was the formation of the Royal Irish Constabulary, a problem to which his attention was turned soon after his arrival at Dublin, and we learn from the same source that "prior to his time the police were an inefficient, partizan, and corrupt body. Catholics were practically

* *Dictionary of National Biography*, Vol. XVI., p. 41.
† *Dictionary of National Biography*, Vol. XVI., p. 42.

Digitized by Google

excluded from the force, and public confidence in consequence withdrawn from it. 'Order' in Dublin was maintained by four hundred underpaid, worn-out, and drunken watchmen, while throughout the provinces the force formed rather a centre of disturbance than a security for peace."

Drummond completely altered this state of affairs. Acting on the principle that peace could be best kept in Ireland by trusting Irishmen —when fairly treated—to keep it, he replaced the watchmen by that great constabulary which was composed principally of Catholic peasants, and which in the course of time has completely justified its existence and has been so greatly increased. He also reorganized the equally untrustworthy local magistrates by placing over them stipendiaries—directly under his own authority—who won the confidence of the people by administering the law with great justice. At the same time, by the suppression of numerous small fairs and by other vigorous methods, he put an end to many of the notorious faction fights which were of such constant occurrence in the south.

One of the greatest difficulties which he had to encounter was the tithe war which had fiercely raged from 1830 to 1834. Although Parliament had declared that the tithe system needed reform, the executive insisted on the collection of tithe—even at the point of the bayonet and at the cost of many lives—until such time as it was actually abolished. Drummond refused to consent to such drastic measures. Police were no longer used to force the payment of the tithes, but the peasants were made to respect those engaged in exercising their legal rights.

The effect of this policy is best described in the following extract from the *National Biography* :—

"The executive no longer appeared as an instrument of a class, but it did not degenerate into a weapon of the popular party. This impartiality was new to the people and won their hearts. Legal rights harshly exercised were no longer enforced, and the people, finding an executive bent on justice, and powerful to protect as well as punish, showed a disposition, hitherto unknown, to obey the law. The peace was kept until the Tithe Commutation Act of 1838 reformed the system and relieved the peasantry from at least the direct payment of the obnoxious impost. The agrarian war also engaged Drummond's attention. In 1833 a strong 'coercion' act had been passed to put down agrarian disturbances, but it had so far failed that in 1834 the Lord-Lieutenant declared that 'it was more safe to violate the law than obey it.' Drummond understood the land question in all its bearings. He was far too sound an administrator not to be aware that, whatever might be the causes of disturbance, law and order should be upheld and outrages put down with a strong hand. Abandoning the old methods, he enforced the ordinary law with vigour. The abandonment of coercion made him popular with the masses of the people, and even those who sympathized with the agrarian organizations forgot the severity in the justice of the ruler. For the first and only time

Digitized by Google

in Irish history an organization of Irish peasants was formed to help the executive in bringing agrarian offenders to justice, and this society was formed in the very centre of agrarian disturbances itself—Tipperary. There was no difficulty in getting evidence against agrarian offenders, there was no difficulty in getting juries to convict when the evidence was clear."

Drummond was equally straightforward in his dealings with the landlords, and pointed out to them how "property has its duties as well as its rights," and also how "to the neglect of those duties in times past is mainly to be ascribed that diseased state of society in which such crimes take their rise"—two truths which have never since been entirely forgotten in the country.

For five years he was practically the Governor of Ireland, managing its affairs with wisdom, firmness, and justice, and making the executive strong, popular, and efficient. Unhappily no man could undertake so stupendous a task of administration and not feel the effects of the strain. His constitution was undermined, and he died in harness on the 15th of April, 1840, after having worked for nine hours in his office on the previous Saturday, the 11th of April.

The details of Drummond's career have been the more fully entered into in the present article, as his name is far less well known in our Corps to-day than it deserves to be. When we consider first his character, and in the second place his achievements both in science and politics, we may well question whether an officer of greater or even equal promise ever wore the uniform of the Royal Engineers.

(*To be continued*).

Digitized by Google

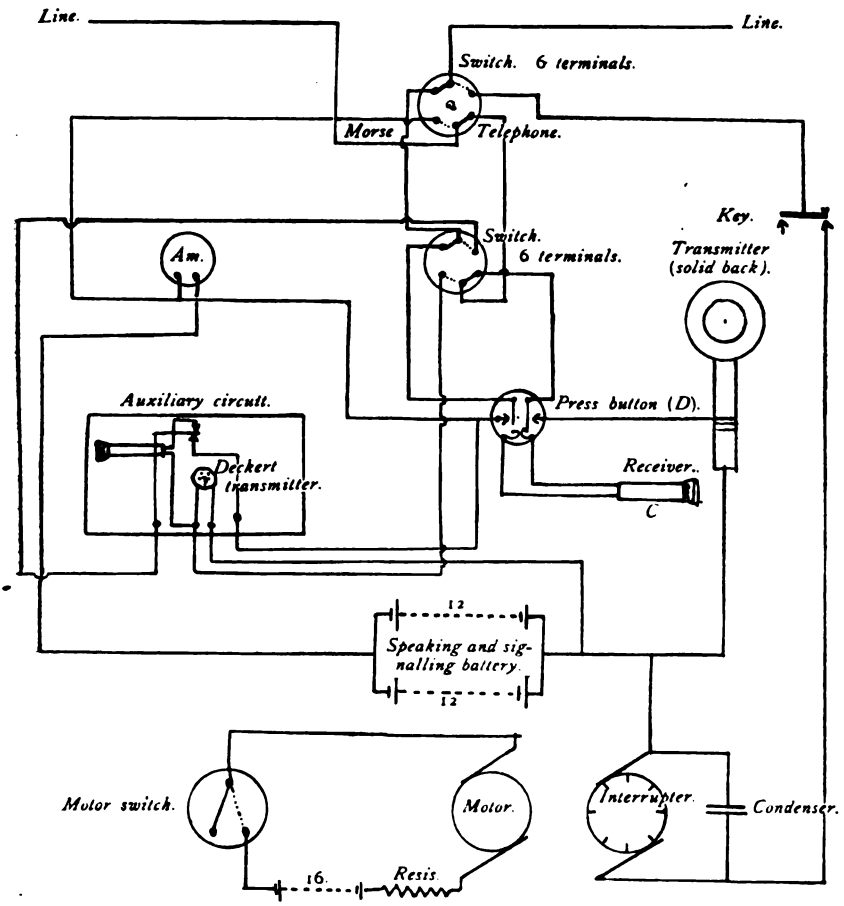
## *TRANSCRIPT.*

### THE SKERRIES WIRELESS TELEPHONE.

From the *P.O. Electrical Engineers Journal*, April, 1908.

THE Skerries are three rocky islets immediately north of Holyhead Bay, and $1\frac{3}{4}$ miles from the coast of North Anglesey. On the centre island stands the Skerries lighthouse. By reason of the extremely rough channel between the island and the mainland—which prohibits the laying of a submarine cable—communication between Skerries and the mainland was a matter of considerable difficulty, until in 1899 it was suggested by the Post Office Engineers that a wireless telephone should be installed.

**SKERRIES INSTALLATION.**




Digitized by Google

The system consists of two parallel conductors earthed at the ends, the adjacent ends being separated by the sea. The Skerries conductor, which is about 500 yards long and is supported on twenty-four 26′ well-stayed poles, is of 600 lbs. copper wire.

The mainland conductor is of 400 lbs. copper wire, supported on twenty-two 30′ poles, and is some 3 miles long. The ends of both conductors are earthed in the sea. From the accompanying diagram it will be seen that with the switch at "telephone," a receiver (C) is in series with the line, but no calling apparatus is provided.

Again, when Skerries "speak," the press button (D) is depressed, and the speaking battery completes the circuit through the transmitter lines and earths. The mainland circuit is a telephone receiver lines and earths, to which energy is probably transmitted by sea-conduction. No satisfactory calling arrangement has been as yet devised—that suggested by Sir Oliver Lodge in 1902 being found impracticable owing to earth currents, which vary from 30 milliamps at low water to 1 milliamp at high water. The difficulty is therefore overcome by speaking at fixed times.

The volume of speech varies considerably, the usual trouble being faint speech. At times however a considerable noise occurs through some unknown cause. In this case the wireless telegraph arrangement is used, and at other times the use of the auxiliary Deckett Transmitter facilitates matters.

The wireless arrangement consists of a motor driven by 16 dry cells. On its armature is placed an interrupter, which, with a key, serves to transmit the message in Morse code. The receiver remains the same as for telephonic purposes.

A. H. SCOTT.

Digitized by Google

# *REVIEWS.*

## RECOLLECTIONS OF A LIFE IN THE BRITISH ARMY.

*By* General Sir Richard Harrison.

Sir Richard Harrison's autobiography is one that cannot fail to interest the general reader, and should provide an instructive object lesson to the younger generation of Royal Engineer officers. It is written throughout in the cheery spirit of one who clearly made up his mind in early youth to make the most of life and its opportunities. An autobiography must of necessity be somewhat egotistical, but the egotism in the book under review is never aggressive, and is always combined with a generous appreciation of those with whom Sir Richard was associated.

The author entered the Service in 1855 (when only 18 years of age and practically straight from school at Harrow)—a critical period in the history of the country, towards the close of the Crimean War, and shortly before the Indian Mutiny and the China War of 1859–60. It was also a most fortunate period for a young officer, one of many opportunities of seeing active service and of sharing in the rapid promotion caused by casualties and augmentations. Of these fortunate opportunities Sir Richard had a good share and made a good use. One effect was that he gained his company in a little more than seven years, receiving a brevet majority some two years later. From that time he never looked back.

Although too late to take an active part in the Crimean War, he did duty at Scutari, where he doubtless acquired useful experience in maintenance of field hospitals, and more especially in surveying, on which work he was chiefly employed.

After a short tour of duty at Malta he was sent to India with a small detachment of R.E., where he arrived in time to take an active part in the Siege of Lucknow and the subsequent campaign in Oude.

He afterwards proceeded to China, where he saw much service in connection with the capture of the Taku Forts, Pekin, etc.—partly with his company (23rd) and partly on the Staff of the Q.M.G.—where he was fortunately employed under Lieut.-Colonel Wolseley, A.Q M.G.

Sir Richard's descriptions of the incidents in India and China in which he took part are graphically related, throwing many side lights on the campaigns—such as do not appear in more formal and official records.

For the next 17 years or so Sir Richard held various Corps appointments, such as adjutant and brigade major at Chatham, and ordinary Corps duties in London, Devonport, and Aldershot, the monotony of which was broken by two official trips to Canada and United States, and by successfully qualifying for the Staff College.

His next active service was seen in the Zulu War of 1879–80 and the subsequent operations against Sekukuni. In those campaigns Sir Richard was chiefly employed on the Staff, and was at one time Com-

Digitized by Google

mandant of the Transvaal. Of the author's description of his share in these wars, the portion that will probably attract most attention is that which refers to the regrettable and much-debated incident of the death of the Prince Imperial. Colonel (as he then was) Harrison came in for a share of the flood of criticism that broke out in England, but his account of the affair strongly tends to prove that the young Prince's sad death was due to his own impetuosity and neglect of precautions in the matter of escort, rather than to any neglect on the part of the Staff.

On return from South Africa, Sir Richard was employed for two or three years at Aldershot, mostly on the Army Staff.

In 1882 he again saw service, in the Egyptian Campaign and subsequently in the Soudan. Space forbids any detailed notice of the good service performed by the author in these campaigns—mostly on the Army Staff in connection with lines of communication. His descriptions of his personal experiences are full of interest.

On the conclusion of the last-mentioned campaign Sir Richard reverted to the Army Staff as A.Q.M.G. at Aldershot, and was afterwards C.R.E. at the same station. In July, 1888, he was promoted Major-General and made a K.C.B. in 1889.

After a year of unemployment, he was given the post of Governor of the Royal Military Academy, whence he proceeded to the command of the Western District, a post he held for the full prescribed period, during which he attained the rank of General.

Sir Richard's next employment was as acting Qr.-Mr.-General at headquarters, a post he held for some six months, when he was transferred to the highest position in his Corps, viz., that of Inspector-General of Fortifications, and occupied it for five years—a period which covered the troublous and hard-working time of the Boer War. This was his last appointment, and thus, appropriately, General Harrison finished—as he began—his career of good service in a purely Corps occupation.

A perusal of this book shows that, with intervals of purely Corps duties, Sir Richard, after the earlier years of his service, held—on his merits—a series of Army Staff appointments. Assuredly some of his good fortune and rapid promotion was due to this fact, and his most successful career both emphasizes how valuable such Staff service is when well performed, and explains why so many of our more ambitious officers strive for appointments outside the Corps.

Another moral to be drawn from this interesting autobiography is the desirability of cultivating a *mens sana in corpore sano*. Few, like Sir Richard, when a Major-General, can play football at the age of 52, to say nothing of racquets at a still greater age.

Finally it may be stated that the book under review displays throughout a spirit of cheerfulness and bonhomie, and leads to the conclusion that the author, in his long service, must have made innumerable friends and few, if any, enemies.

All R.E. officers will unite in wishing General Sir Richard Harrison many years of health and happiness in his well-earned retirement, after such a varied and useful career, and in thanking him for a book which cannot fail to be read with profit and enjoyment.

Digitized by Google

## TOPOGRAPHICAL SURVEYING AND SKETCHING.

By Thomas H. Rees, Major, Corps of Engineers, U.S. Army.—(U.S. Cavalry Association, Fort Leavenworth, Kansas. Price $2.50).

The above is the authorized textbook of the U.S. Army Service Schools, and has been prepared from the instructional lectures and pamphlets in use there.

The treatment of the various survey subjects dealt with, is guided by the desire to give the student such insight into them as is likely to be required for military purposes, and within a small compass. It is therefore more elementary than exhaustive.

The difference should be more clearly accentuated between the deliberate work required for map production in peace time, and the rapid field sketch which satisfies some particular military situation in war. Unless this distinction be kept in mind, there is always the danger that methods practised will be insufficiently accurate for a good topographical map, whilst unnecessarily complicated and too slow for war sketches.

For instance, sketchers should be taught to fix the heights of hills and valleys, interpolate the number of contours by calculation, and then space them by eye; not to calculate the H.E. (= M.D.) between each contour to two places of decimals of an inch and plot slopes in the piecemeal fashion of ancient practice. Such methods give a wrong idea of the broad treatment necessary in rapid military sketching. Moreover, the nice calculation of results, from readings of instruments which are *known* to be inaccurate, is a work of supererogation.

The habits engendered in the surveyor are partly antagonistic to those required in the sketcher, and a distinct caution as to the different ends in view is very necessary. Sketches are not maps.

Some useful hints are given on combined sketching, a subject more fully dealt with in a book by Capts. Cole and Stuart, and also published by the Cavalry Association. The general control is obtained by traverse Where a good small-scale map exists, as in most civilized countries, the control would better be furnished by an enlargement therefrom cut up for issue to various sketchers, or, better still, traced in sections on to celluloid sheets with margins.

The transit theodolite is explained in Chapter IV. The pattern with four instead of three levelling screws is referred to, albeit this is an unsound construction. However the instructions for levelling the instrument are good. The adjustments for the Wye Level are not given in the best order. Some notes are given on field astronomy, the use of a sextant, and measurements with a steel tape, sufficient for rough work.

Considerable labour has evidently been expended in the preparation of this volume, and the printing and plates are satisfactorily executed.

Digitized by Google

## WAR SONGS.

SELECTED BY CHRISTOPHER STONE.—(Clarendon Press. 2s. 6d. net).

An interesting collection of "War Songs," selected by Christopher Stone, has lately been published by the Clarendon Press. The introduction is by Sir Ian Hamilton, and deals principally with the value of war songs and the partiality shown for them by the British soldier. The songs themselves are some 90 in number, and include not only most of the well-known favourites, but also many quaint old rhymes which have practically been long since forgotten. Although many an old Scotch or Border song is to be found, it seems curious that some of the most soul-stirring lines, which have ever been written on war, should be omitted from the selection. For instance, neither Byron's "Waterloo," Tennyson's "The Relief of Lucknow," nor Kipling's "Recessional" find a place, although "The Charge of the Light Brigade" and "Hohenlinden," amongst others, show that the selection is not intended to be marching songs only.

The book is well annotated and has an additional "Index of First Lines" which is likely to prove most useful.

Digitized by Google

# *NOTICES OF MAGAZINES.*

## KRIEGSTECHNISCHE ZEITSCHRIFT.

*September*, 1908.

Under the heading of "Russian Opinions as to the Rate of Building Fortifications," reviews are given of some articles which have recently appeared in Russian military journals, and which show the reaction that has taken place since the Russo-Japanese War.

The common opinion expressed by all these articles is that a fortress, whose permanent works are in process of construction, is worse off at the outbreak of war than a place which has no permanent works at all, for in the case of the former the necessary stores for building the work take up room—thus making communication difficult and reducing the field of fire. To avoid this state of unpreparedness the following course is proposed:—Defensive positions are chosen for a place according to its strategic importance and to local requirements. A garrison is then sent there and fieldworks are erected round the place. In a few weeks or months these will be converted into semi-permanent works by civilian labour, and finally after a year or two into permanent fortifications; the strength of the garrison can then be reduced by one-third without diminishing its power of resistance.

The cost of a fort for two companies, with a firing line 425 mètres long, is given as 2 million roubles (1 rouble = 3s. 2d.), and will take 1,000 workmen 800 working days (or 3 years) to build. The cost of placing semi-permanent works on a perimeter of 54 kilomètres is estimated at 40 million roubles, and the time required at 1½ to 2 months.

Prince Tomanoff expresses the opinion that a weakly fortified place—especially on the frontier—is worse than an unfortified one, as its capture gives the enemy a cheap moral victory. He considers that bombproofs for the garrison are of primary importance. These can be constructed for one company of infantry, for light Q.F. guns and machine guns and their detachments (324 men in all), in four weeks, and further in nine more days they can be converted to useful auxiliary points with glacis. The construction of bombproof magazines, and store rooms for explosives and other easily inflammable substances such as spirits or petroleum, should be begun at the same time and should be finished in the first year. In the second year the intervals between the forts should be filled in, trenches deepened, and accommodation for the garrison built; the third year sees the fortress finished in all such details as mining galleries and obstacles, whilst for the following two or three years the workmen are kept busy by the construction of the

Digitized by Google

road system and the erection of depôts inside the kernel of the fortification, as well as on a wall round the kernel itself.

Prince Tomanoff, as well as Timtshenko-Ruban, is opposed to the idea of converting simple fieldworks into permanent works, on account of the large amount of labour involved in the transport and handling of concrete. The latter authority recommends the commencement of the external line of permanent defences as the first operation, as this allows time, in case of an attack, to construct the second line. He also states that skilled labour will not be difficult to obtain, as most fortresses exist as the defences of railway junctions, or of towns important mainly for their trade and manufactures. He recommends as the programme to be followed in the construction of each individual work :—

*1st Year.*—The trenches in the work and its armouring from the roof to the ultimate ground level.

*2nd Year.*—The casemates under the parapet.

*3rd Year.*—The emplacements for close-range artillery.

*4th Year.*—The ammunition magazines.

The advantage claimed by this system is that a work is made bomb-proof as soon as possible, and inner details are seen to later in the fifth year, whilst in the sixth year the hitherto provisional means of communication between forts and batteries, in the intervals and their magazines, are made permanent, and the field of fire improved by deforestation and clearances. Finally, less important communications are improved or made. The article closes by a few remarks on coast defence. A prolonged battle between coast defences and warships is unlikely, but if made when the attacker is strong enough, will take place when the ships are 5 to 6 kilomètres from the shore. The coast defences will consist of the following :—(1), the long-range guns, which also serve to defend distant minefields; (2), guns for the protection of closer minefields; (3), batteries to resist a landing; and (4) guns for fighting at close quarters. The situation of the defences on the land side depends on local tactical requirements. The suggested order of construction of the various defences is—firstly, the planning and masking of gun emplacements; secondly, the installation of rangefinders and electric projectors; thirdly, the erection of observation and firing cells for the minefields; fourthly, the cement parapets should be made as well as expense magazines; and finally, the reserve magazines should be built. The defences on the land side should be carried out on the principles already laid down for land works.

---

NEUE MILITÄRISCHE BLÄTTER.

*4th and 12th October*, 1908.

THE IMPERIAL MANŒUVRES IN ALSACE-LORRAINE.—The theatre of operations chosen being heavily wooded, cut up with streams, rivers, and artificial waterways, and with but few townships, made great demands

Digitized by Google

on the mobility of all arms. After the least rain the difficulty of marching was greatly increased by the clayey nature of the soil. The badly graded main roads with their continual rise and fall wearied the infantry. The dung-heap at the door of every house and the typical Lorraine village increased the difficulty of billets, and the prevalence of typhoid in the district was an added danger to be guarded against by the responsible authorities. Under service conditions however such difficulties must be faced, and the experience was valuable. The manœuvres were the largest since 1893, conducted under the Kaiser's supervision. "Blue" consisted of the XV. Army Corps, the Bavarian Cavalry Division, and the 3rd Bavarian Infantry Division. The "Red" side was formed by the XVI. Army Corps and the Cavalry Division "A." The 8th Bavarian Infantry Brigade of six battalions and a composite battalion of field artillery were added during the manœuvres. The writer of the article describes the course of the fighting, and then observes that the troops were severely tested, although the weather was on the whole good. On September 7th the 33rd Infantry Division in warm weather marched 52 kilomètres without showing distress, and on the same day the Cavalry Division "A" did 70 kilomètres. No cases of heat stroke were reported. "According to the new regulations"—modelled perhaps on Japanese experiences—skirmishers were used, who made every use of cover in their advance, and only opened fire when they had gained the fire position; covering fire, from a position in rear, was utilized to assist their advance. The noiseless work in line of skirmishers is commended; indicating that a high grade of fire discipline was observed, fire increased or diminished without words of command being heard as the enemy offered a target or withdrew under cover. The writer of the article observes that two years ago everyone, from the colonel of infantry to the private, got into a state of excitement which was wont to express itself in shouted orders and abuse. The field artillery of both sides however seemed to have clung to old traditions in this respect. The work of the cavalry appears to have been up to date according to our ideas. Positions, of which they gained possession, were immediately defended by dismounted troopers supported by the machine-gun detachments. The field artillery sought to avoid the old favourite artillery duel, and when possible directed their fire much more against the infantry. The infantry attack was supported up to the shortest range by batteries pushed right forward, but, with a few exceptions, the gunners omitted to dig themselves in.

Three pioneer companies were used by "Blue" as infantry. In the strengthening of Red's position on the night of the 9th—10th and on the morning of the 10th the pioneers found extensive employment, and were keenly assisted by the infantry. Little experience was gained this year in bridging. Mechanical transport was used for the baggage and supply of the XVI. Army Corps. Thus the 33rd Infantry Division (380 officers, 10,200 men, 1,800 horses) had 9 lorries with 7 trailers, the 34th Infantry Division (500 officers, 15,400 men, 2,130 horses) had 10 lorries and 17 trailers, and the Cavalry Division (200 officers, 3,580 men, 3,580 horses) 10 lorries and 8 trailers. The supply columns filled up in Metz

Digitized by Google

and Remilly, and brought the supplies to the intermediate depôts, which changed according to the movements of the troops. From these the troops fetched, in their regimental transport, their requirements for the next day—the automobile columns then went back to Metz and Remilly, loaded in the evening, and drove laden the next morning to the new intermediate depôt. They had to do an average of 80 kilomètres a day, which in view of the nature of the country was pretty heavy. The new travelling field kitchen, nicknamed "The Peashooter," gave satisfaction.

Referring to the increasingly complicated methods of communication, the writer thinks that in war the old method of despatch riders on picked horses will again be resorted to.

The volunteers of the German Motor Bicycle Union turned out 180 strong.

The captive balloons were able to make ascents each day, but no comment is made on their utility.

THE GERMAN MILITARY AIRSHIP.—The issue of 31st October, 1908, contains an article entitled "The Official Report of the Great Flight of the Military Airship." The flight lasted 13 hours, and is considered a record. It was not a speed trial, but was undertaken both to test the airship's endurance and the possibility of proceeding between fixed points. The goal was Magdeburg. For one-half of the trip, only one motor was in use; during the remainder two motors. The airship started from Tegel and reached Magdeburg in 9 hours 40 minutes, returning in 3 hours 21 minutes. The airship only made 68 miles in eight hours against the wind, whilst with the wind it accomplished 80·7 miles in three hours. The gas used was five weeks old, but the vessel remained for nearly five hours on end at a height of over 3,000'. It is claimed that the practical utility of the military airship was evinced in a special way by unforeseen events. For instance, about 4 o'clock at night the wind increased to such an extent that both motors had to be employed at high speed. As a result one motor broke down and was put out of action for an hour, but the repairs were effected in the air. Later one of the steering lines got out of order, so that the reserve line had to be taken in use. The repairs lasted three-quarters of an hour, but did not affect the flight. It is claimed that the airship has thus proved that the putting out of action of one motor does not affect the flight or steering. The rigid airship has done a 12-hour flight and the non-rigid 11½ hours, so that this flight may be taken as a world record. According to the writer of the article, the French airships have not done more than seven or eight hours, and he also remarks that the Russian airship can only be regarded as a large model, and no importance need be attached to its trials. It has a very heavy substructure, of which the practical value has not yet been proved.

During this flight 33 lbs. of ballast were spent, while the store of petrol and lubricating oil would have permitted a further flight of four hours' duration. It is claimed that this flight has proved that the airship in favourable weather can keep in the air for 17 to 18 hours. The limit of its radius of action will be tested by further trials.

Digitized by Google

The conditions of contract stipulated that the non-rigid airship should keep a height of 1,500 mètres (about 4,900′) for at least one hour, and the rigid airship reached on its trip on the 4th August a maximum of 1,000 mètres, which it could only maintain for quite a short time on account of the considerable loss of gas that ensued. The writer goes on to say that the advantage of having ballonets in high flights is unquestionable. The size of the ballonets will generally be calculated so as to prevent loss of gas at a height of 1,500 mètres.

In making comparisons between the rigid pattern and non-rigid pattern of airship, it must be remembered that the latter is small, and its performances cannot be expected to compare with those of great ships of the rigid type.

The German War Automobile.—An article on the results of trials with motor transport in the 1908 Kaiser Manœuvres appears in the November issue. After sketching the opportunities which the future holds for this type of transport, the article proceeds to give some details of the wagons employed. The 33rd Infantry Division had the greatest variety in its "automobile column," which consisted of one Siemens-Schockert train (motor wagon with five trailers, capacity 15 tons), one 30-h.p. Stoltz wagon (one trailer, 6 tons), one 20-h.p. Stoltz wagon, one Büssing lorry '06, one Gaggenau lorry '07, one Ducommun lorry '07, one D.A.G. lorry '05 (one trailer, travelling workshop), one light Argus supply wagon (spare parts and tools), and two passenger cars (Kolonnenbegleitwagen). The Cavalry Division was equipped with eight lorries of the type of a light military wagon, which has been constructed in various motor-car factories for the German War Department, and is the result of prolonged trials. These wagons proved the best, although all the others came up to requirements. The daily run averaged 90 to 100 kilomètres, half of which was accomplished with loads. The Siemens train, constructed somewhat after the Renard principle, proved very practical, viz., each separate wagon having its own driving road wheel, in order to get sufficient adhesion with the heavy load. The difficulty of turning the train is avoided by the tractor being capable of being coupled at will at either end. It is also possible, by cable leads, to connect single trailers to the electrical power of the tractor, and—while the train halts—to run these separate trailers to any desired place, such as a bivouac situated to one side of the main road.

E. G. Wace.

---

## Rivista di Artiglieria e Genio.

*November*, 1908.

The Map of Italy, Scale 1 to 250,000, of the Italian Touring Club.—The Italian map, on a scale of 1 to 250,000, edited by the Italian Touring Club, is an important publication which does honour to the country, and which constitutes a remarkable means of national culture.

Digitized by Google

The complete map will contain 58 sheets. The sheets measure 335 mms. by 450 mms., and cover an average area of about 9,240 square kms.

As a work of technical lithography this map—printed at Rome at the Geographical Institution of Dr. De Agostini—can compete with the most artistic maps both as regards detail and general quality. The maps are printed in nine colours. There are itineraries and measurements of declivities, and on the great roads of communication the distances are marked in kilomètres.

The districts are accurately represented with the addition of the latest works; Naples, for instance, contains an index showing the new industrial buildings which cover a very large area; also the plans of Rome show clearly the great arteries, with the principal palaces and other great buildings in the capital. Lastly, the coast beacons, the stations for wireless telegraphy, the central isolated electrical stations, both the main and smaller lines of railway, the tramways, etc., are all shown, as are also the woods, which have not hitherto been shown on maps.

MOUNTED PIONEERS IN RUSSIA.—An article taken from the *Militär Wochenblatt* contains a favourable account of the mounted pioneers in the Russian Army. For many years two divisions (four squadrons) of mounted pioneers existed in the Russian Army. They were formed in 1819 and disbanded somewhere about 1862.

The two last wars—viz., the Russo-Turkish and the Russo-Japanese—have clearly shown the need of resuscitating these troops, as in both of them the mounted pioneers have been employed with advantage.

In the war of 1877–78, four days after the passage of the Danube, a detachment of mounted pioneers was formed of Cossacks. A sotnia of sappers was formed from sappers taken from the Cossacks of the Don, and from other Cossacks a sotnia of pontoniers was organized with the Cossacks of the Ural. An officer of Cossacks—as commandant—and three officers of sappers were appointed to the first, whilst the sotnia of pontoniers had all its organization taken from the Cossack cavalry and was commanded by an officer of pontoniers. The two sotnia were reunited in an independent "division," commanded by Colonel Count Reniker, who was recalled from leave for this purpose.

To the sotnia of sappers were allotted three pack carriages—one for entrenching tools, one for electric material, and one for explosives. Each mounted sapper was also provided with suitable tools. The material for the pontoon sotnia was taken from the equipment of the regular bridging battalions.

On the 3rd July, 1877, the division of mounted pioneers attached to the advance guard of General Gourko set out from Simnitza by Sistova, where it arrived somewhat late owing to damage done to the heavy carriages which were behind on the march. In the march which followed to Tirnova (75 kms.) the detachment—owing to the same causes—was four days in reaching the station.

At Tirnova the commandant of the pioneer division obtained permission from General Gourko to lighten the heavier carriages, and only

Digitized by Google

retained four pack wagons containing the tools indispensable for pioneer services. Notwithstanding this they still had to contend with great difficulties on the march from Tirnova to Hajnkiöj owing to the pack wagons, and it was found necessary to leave another wagon behind.

However these improvised pioneers rendered satisfactory service, keeping all the roads of the Balkans in good repair, so that all the troops of General Gourko's advance guard were able to push on without stop. The pioneers worked incessantly for four days. During the march itself, and later on when no technical work was required, the mounted pioneers were utilized for reconnoitring purposes.

After the capture of the Schipka Pass, General Gourko ordered the formation of a special mining detachment, composed from the sotnia of the Don, with a cavalry officer, two sapper officers, and 60 selected men, with the best horses available. The detachment was told off to destroy the Adrianople-Jeni Zagra Railway. The material, together with the explosives, was carried in forage sacks. The mining detachment was divided between the two dragoon regiments of Astiakan and Koran. Special sapper officers were employed to carry out the destruction of the railway. Several bridges were mined, many lines of telegraph were cut, and finally the railway station of Jeni Zagra was destroyed.

The division of mounted pioneers was employed both in mining and in fortifying the Schipka Passes.

Afterwards the sotnia of the Don was disbanded and the sappers returned to their own battalions; the sotnia of the Ural was retained, but was only used for cavalry services. On the advance on Adrianople another detachment of mounted pioneers was formed, but this time it was taken from the regiments of regular cavalry.

The mounted pioneers, during the Russo-Turkish War, proved to be of great use, although they were only raised in a time of need, had no knowledge of the special technical work entrusted to them, and were provided with heavy wagons not adapted to the work.

After the war the superior military authorities were induced to recognize the necessity of instructing cavalry in pioneers' duties. The officers and troops of cavalry were from time to time attached to the sapper battalions. The result of this however was not satisfactory, as the individuals who went through courses of instruction with the sappers failed to show any practical knowledge, and soon forgot what they had learnt theoretically. This was shown during the last war. The cavalrymen, who had been attached to sapper battalions, were not versed in the use of explosives for destructive purposes, and were useless in other technical matters which should form part of the duties of officers and men of the pioneers.

The author of the article in the *Invalido Russo* concludes by expressing the hope that in time of peace regular detachments of mounted pioneers will be organized, seeing that the instruction of the cavalry for so short a time with the sapper battalions is not sufficient to form pioneers, and that it is impossible for individuals of the sapper battalions to undertake service on horseback in war time only.

To each cavalry division, according to the author, a squadron of

Digitized by Google

pioneers should be assigned, and this again could be subdivided into four detachments, which could be employed independently.

AUSTRIA-HUNGARY.—*The New Regulations for Field Fortification.*—The orders proscribed in the Austria-Hungarian Army for field fortification, and which until now have been dispersed in various official publications, will now be all collected under the title "Regulations for Field Fortification." This book will, according to notices in the *Fremdemblatt*, be the principal modern work on this subject, and will be a valuable guide for the officers.

The regulations are divided into three parts, treating respectively of the principal tactics in relation to field fortification, of their technical application, and the distribution of the works.

In the technical execution of works it is necessary, when occupying the ground, to take all possible advantage of its natural undulations.

The regulations lay stress on the importance of the observation of artillery fire, and of the communication which should exist between the observatories and the commanders of batteries.

EDWARD T. THACKERAY.

Digitized by Google

# *RECENT PUBLICATIONS OF MILITARY INTEREST.*

## JANUARY, 1909.

(*Published Quarterly*).

THE following extracts from the list compiled by the General Staff, War Office, are published in the *R.E. Journal* by permission of the Army Council.

## HISTORICAL.

FROM ISLAND TO EMPIRE. By J. S. C. Bridge, with an introduction by Sir Cyprian Bridge. 343 pp., with index and maps. 8vo. London, 1908. Chatto & Windus. 6s.

This volume contains a most excellent outline of the growth and consolidation of the British Empire from the commencement of Queen Elizabeth's reign up to the conclusion of the late South African War.

It is divided into twelve chapters, dealing separately with the operations which took place (often concurrently) in different parts of the world. Commencing with the early struggles with Spain and Holland and the wars of Marlborough, the author passes on to the situation in America, the Seven Years' War, and the Conquest of Canada. He then devotes one chapter to the rise of the Empire in India, and three more to subsequent events in India up to the end of the Indian Mutiny. The War of American Independence occupies two chapters, and Nelson and Napoleon, Egypt and South Africa, are allotted one chapter each.

In a book of this size it is impossible to deal fully with each phase of history in a period extending over three and a-half centuries, but the salient points have been described in sufficient detail to give a very good general idea of the whole, and it forms a succinct history in which the interest is maintained throughout, and the necessity for co-operation between the Navy and Army is fully brought out.

The author hopes that readers of the book may be induced to proceed with the study of those authoritative works to which he frequently makes reference in the text, and this is by no means unlikely, as interest is sure to be aroused in all who read it.

The index is good and sufficiently full to be of considerable use for reference purposes, and a chronological table of events at the commencement of the book is a useful adjunct.

THE CAMPAIGN OF 1805 IN GERMANY (La Campagne de 1805 en Allemagne). Historical section of the French General Staff. 770 pp., with 15 maps. 8vo. Paris, 1908. Chapelot. 17s. 6d.

This volume deals at considerable length with Napoleon's strategy after the capitulation of Mack at Ulm; it describes the operations against Kutusow, which culminated in the defeat of Mortier by superior numbers at Dürrenstein, and shows how the Russian leader succeeded in frustrating Napoleon's attempt to crush his army. Immense care has been taken to obtain the necessary documentary evidence, with the result that the work is complete and of great historical value.

Digitized by Google

WATERLOO (Waterloo). A French translation by General Goiran of the Italian book by General Albert Pollio, General Officer Commanding 25th Infantry Division, Italian Army. 640 pp., illustrated by photographs. 8vo. Paris, 1908. Lavauzelle. 9s. 6d.

This is a careful study of the Waterloo Campaign, which the author has evidently done his best to keep unbiased. The volume shows clearly that most of the information has been derived from French sources, and leads one to suppose that the author is of opinion that British, Dutch, Belgian, and Prussian sources are untrustworthy, as they all seek to magnify the part played by the troops of their own nation in the great victory; possibly also General Pollio knows French better than the other languages, and has found it easier to devote his attention to the French literature on the subject.

The author evidently has a very high admiration for Napoleon, and has come to the conclusion that the success of the allies in the Waterloo Campaign was due more to good fortune than to skill, either in strategy or in tactics. He looks upon the Duke of Wellington as a stubborn fighter and cool leader, but apparently has a poor opinion of his powers as a strategist. In his criticisms on the Battle of Waterloo, General Pollio hardly gives sufficient credit to the British infantry, whilst his admiration for the French troops, fully justified as it is, rather tends to warp his judgment with reference to their opponents. In speaking of the numbers at the disposal of Napoleon and Wellington respectively he does not give sufficient weight to the fact that the Anglo-Dutch Army was a heterogeneous mixture of four nations, of whom a fairly large proportion had little interest in the struggle; whilst the French troops consisted of seasoned veterans, under famous generals, fighting under the eye of their beloved Emperor, who was staking everything on the success of this last battle in his career.

The translation is good and accurate, and the French is easy to read.

THE CAMPAIGN OF 1815 IN THE NETHERLANDS, Vol. I., Quatre Bras (La Campagne de 1815 aux Pays-Bas). By Colonel de Bas, Director of the Historical Section of the Dutch General Staff, and Colonel Count T'serclaes de Wommersom, of the Belgian General Staff. 548 pp. 8vo. Paris, 1908. 18s.

This book is a plea for a fuller recognition of the part played by the Dutch-Belgian troops in the Waterloo Campaign. The authors, who have had access to many little known documents, remark that it has become traditional to depreciate the valour of their countrymen in this campaign, and that recent historians have repeated the calumnies of earlier writers. The book commences with an account of the sufferings endured by Holland and Belgium under the rule of the Republic, and later of Napoleon, thereby showing how little cause the inhabitants of these countries had to be in sympathy with France.

The history of the various corps of the Dutch-Belgian Army is given in detail, and the difficulties of organizing the new army in 1813-14, with the limited financial resources at the disposal of the Government, are described. Coming to the events of the 100 days, much space is devoted to the consideration of the situation of the allied armies on the 14th and 15th June, 1815. The authors, without reflecting upon the sagacity of Wellington, for whose skill and ability they express the greatest respect, evidently consider that the Duke adhered too long to the view that Napoleon's main movement would be towards the British right. They hold that the initiative of General Perponcher in marching to Quatre Bras on the night of the 15th-16th, in opposition to the orders directing him to concentrate on Nivelles, was mainly instrumental in repairing the mistake and preventing the interruption of Wellington's concentration. The book concludes with a detailed account of the Battle of Quatre Bras and of the part played by the Dutch-Belgian troops in that engagement.

Digitized by Google

GRANT AND LEE IN VIRGINIA. By Lieut.-Colonel H. M. E. Brunker. 63 pp. 8vo. London, 1908. Foster Groom. 3s.

A summary of the operations in May and June, 1864, and, if read in conjunction with fuller accounts of this campaign, should assist officers in preparing for the Military History Examination for Promotion, which is the object of the book. The sketch maps are clear.

FOUR YEARS UNDER MARSE ROBERT. By Robert Stiles, Major of Artillery in the Army of Northern Virginia. 3rd edition. 368 pp. 8vo. New York, 1904. The Neale Publishing Co. 8s.

Major Stiles' reminiscences of the Civil War have already achieved a well-deserved popularity. His picture of War, from the personal point of view, is drawn with the sure hand of one who has witnessed what he relates, and with the balanced judgment of a mind which has long pondered its subject.

After the first Battle of Manasses the author enlisted in the Richmond Howitzers, and from that day till 6th April, 1865, when he was taken prisoner at Sailor's Creek, he served with the Army of Northern Virginia. He was present at the Battles of Williamsburg and Seven Pines, and throughout the Peninsular Campaign, but was not at the Second Manasses or Sharpsburg. His artillery section, which had been sent to Richmond after Malvern Hill to be re-equipped, joined the main army in time to take part in the Battle of Fredericksburg, and bore its share in all Lee's subsequent battles till the end of June, 1864, when the whole battalion was transferred from Petersburg to the lines between the Appomatox and the James, and remained there virtually without firing a shot till 2nd April, 1865. Promoted to the rank of major in December, 1864, the author was posted to the battalion of heavy artillery at Cheffin's Bluff, and commanded it during the retreat from Richmond. His military career closed amid a blaze of glory, for after the surrender of the Confederate forces at Sailor's Creek, General Ewell called him up and publicly congratulated him upon the record which his battalion had made in that engagement.

His whole service was passed with the artillery, though he received his first commission in the engineers, and "was actually advanced one grade in engineer troops for meritorious service in artillery." He claims for the artillery of Lee's Army that "in proportion to its numbers it furnished perhaps more officers below the rank of general who were conspicuous for gallantry and high soldiership than either of the other two arms," and he adduces some very good reasons to show why this was so. Incidentally he remarks that during the latter part of the war an infantry company in the Army of Northern Virginia did not average over fifteen or twenty men. During the campaign of 1864 he acted as adjutant to Cabell's battalion, and consequently his knowledge of that campaign is more comprehensive and detailed than of any other. Of special interest is his account of the Bloody Angle at Spotsylvania. On the 12th May his battalion was put in at the left base of the salient, but he differs from the majority of writers in maintaining that, though the fire was at times heavy, yet at no time in front of his position did it approximate the intensity of the fire during the great attack at Cold Harbour. It appears from this narrative that, had not Grant, after Cold Harbour, crossed the James, Lee would have attacked him, and Early had been appointed to lead the attack, when the operations of Hunter in the Shenandoah Valley necessitated the abandonment of the plan.

Naturally Lee is the hero of the book, and from its pages can be realized something of the intense devotion with which the Army of Northern Virginia regarded their great leader. Next to Lee, Jackson seems to have commanded the author's greatest admiration, though he never served under him. He describes an interview, of which he was, perhaps, the only witness, between Lee and Jackson during the Peninsular Campaign, which closely resembles the well-known interview between the same generals preceding Jackson's flank march during the Second Manasses Campaign. Vivid pictures are also given of D. H. Hill, with his monomania on the subject of personal courage, and of Jubal Early, Lee's trusted lieutenant in spite of his eccentricities.

Digitized by Google

One of the last chapters of the book is entitled "Fatal Mistake of the Confederate Military Authorities." This mistake was their failure to realize that promotion is "the informing spirit of an army." Not even Lee himself had power to confer promotion on the field. It had to come through the War Department, and the process was slow. Where gallantry was officially recognized the promotion lagged and followed so far behind that the heroic deed had by that time been forgotten, and the moral effect was almost, if not entirely, lost. The author's own case is typical. He was recommended for promotion for gallant conduct on 12th May, 1864, but the promotion did not come till more than six months after, and the commission ranked not from the date of the engagement (of which not the slightest mention was made), but from the date of its issue. The attempt of the Government to establish badges of distinction and a roll of honour was rendered futile by the absurd provision that the recipients of such honours were to be selected by the men themselves. The author also condemns the system, which was first adopted, of allowing the soldiers to elect their own officers. The monstrosity of such a mode of selection is sufficiently proved, in his opinion, by the fact that one Virginia regiment successfully protested against the assignment of Jackson to command it. In spite of official discouragement Lee's Army attained a high standard of discipline, as is admitted by General Hooker, who attributed to it his defeat at Chancellorsville. Not the least of the influences promoting discipline and order was probably the religious revival which took place in the winter of 1864 at Fredericksburg.

GRANT'S CAVALRY IN THE GETTYSBURG CAMPAIGN. By J. S. Mosby. 222 pp., with portraits and map. 8vo. New York, 1908. Moffat, Yard. 8s. 4d.

This work is of a controversial nature, in which the author undertakes to clear General Stuart of the charge of having been the cause of the failure of the Gettysburg Campaign.

The first chapter deals with the cavalry battle of Brandy Station or Fleetwood, with regard to which the author makes the following important points: —

1. Stuart was not meditating a raid, as stated by Hooker and Phasonton. He had massed his cavalry in Culpepper County partly to screen Ewell's movement to the Shenandoah Valley, partly to guard against a repetition of the Stoneman raid, and partly to get the benefit of the rich pasture grounds in that neighbourhood.
2. Pleasonton crossed the Rappahannock to fight Stuart, did fight him, and was fairly beaten. The author maintains that to cover up his defeat Pleasonton invented the theory that he was sent to make a reconnaissance in force and voluntarily withdrew when he had effected his purpose. In support of this view several facts are quoted.
3. Pleasonton gained no information worth having by his expedition. The author justifies this statement by a reference to significant movements of the enemy on days immediately succeeding the cavalry battle, all of which remained undiscovered by Pleasonton.

The rest of the book is devoted to the Gettysburg Campaign. The author bases his case upon alleged discrepancies between Lee's two reports and the inaccuracy of them both, when compared with the correspondence and orders since published. The discrepancies however do not seem to amount to very much. Both regard the absence of cavalry as the cause of the premature collision of the 1st July. The author attributes the failure of the campaign, on the other hand, not to Stuart's absence but to Heth's presence at Gettysburg. He attacks both that General and his corps commander, A. P. Hill, and even goes so far as to impugn the veracity of Lee's second report. The arguments with which Colonel Mosby supports his case are undeniably strong and entitled to the closest attention, but are unmistakably those of a strong partizan and not of an unbiased critic; they cannot therefore be accepted without reserve; nevertheless the book assists materially to elucidate the campaign.

Digitized by Google

OFFICIAL HISTORY OF THE RUSSO-JAPANESE WAR. Part II. Prepared by the Historical Section of the Committee of Imperial Defence. 164 pp., with 12 maps. 8vo. London, 1908. 5s.

This is a continuation of the Official History, Part I. of which was published by the General Staff. It forms an advanced portion of the combined naval and military history which is in course of preparation, and deals with the operations from the Battle of the Ya-lu to Liao-Yang, exclusive. It contains no comments, and naval operations have been touched on only in so far as they affect the movements of troops on land.

ACCOUNT TO THE CZAR OF THE RUSSO-JAPANESE WAR (Rechenschaftsbericht an den Zaren über den Russisch-Japanischen Krieg). By General A. Kuropatkin. German authorized translation by Navi. 371 pp., including 32 appendices and a preface. 8vo. Berlin, 1908. Risel's Deutsche Centrale für Militärwissenschaft.

This work, which is published by authority, contains four chapters. The first deals with the operations up to and including the Battle of Liao-yang; the second treats of fighting on the Sha-ho; the third describes the "operation" of Mukden. The fourth chapter, which bears the title "Conclusion," is also devoted in part to a discussion of the fighting around Mukden, and ends with a review of the conditions under which the war was fought and of the results achieved.

In a preface the translator draws attention to the alleged causes of the Russian defeats, viz.:—Differences of opinion and the lack of uniform military thought. He quotes the author, who says that in every rank there was a lack of men endowed with true soldierly qualities and with the iron nerves which would have enabled them to endure, without any weakening of purpose, fights which continued for days.

In Chapter I. we are told that Alexieff originally considered 16 battalions of infantry as sufficient for the defence of the Kwantung Peninsula. This number was afterwards increased to 36, and after Makaroff's death the Viceroy called for early assistance from the Russian field army, since "strictly speaking Port Arthur cannot be considered as a fortress—it ought to be able to resist a sudden attack, but could hardly sustain a siege of two or three months." Stoessel concurred in these views. The Russian Commissary General at Port Arthur, unaware of the abundance of supplies in Manchuria, ordered them from Europe. General Sassulitsch excused his disobedience in fighting the Japanese on the Yalu on the grounds that he reckoned on success. The way in which Russian reinforcements were sent backwards and forwards between Hai-cheng and Liao-yang led to a hopeless mixing up of tactical units at an early period of the campaign. They were the outcome of plans, hastily formed and as hastily abandoned, for offensive movements southward, towards Port Arthur, and eastward. Kuropatkin discusses these plans, and points out incidentally that paucity of transport and mountain artillery rendered the Yalu project impracticable. The Xth Corps, which was the first to arrive from Europe, is severely criticized by the Commander-in-Chief. Many of the reservists were small and awkward, and the older men amongst them were aggrieved at being called out before younger categories. Many of the higher commanders were fresh to their posts and unfit for them. On an average, 800 men (out of 4,000) in each regiment were away from their unit Of the courses open to him on the 18th August, viz, (1) to move against Oku and Nozu whilst observing Kuroki, and (2) to retreat on to the main Liao-yang position whilst opposing Kuroki with as large a force as possible, Kuropatkin chose the latter, as (1) would have led to disaster in the event of Kuroki being successful against the covering detachment. In discussing the alternatives open to him on August 21st* he refers to the spontaneous retreat of several of his subordinate generals, with the consequent probability of the Japanese right wing penetrating as far as the railway.

* These dates are O.S., and 13 days must be added in comparing them with non-Russian accounts.

Digitized by Google

Chapter II. opens with a consideration of the position taken up by the Russians after Liao-yang. Amongst its disadvantages he cites :—

(1). The undue échelonning to the rear of his left wing due to a re-entering bend in the Hunho, east of Mukden. As a result of this a success of the enemy on this flank would have brought him on to the Russian communications.

(2). The proximity of the Hunho in rear of the position.

(3). The fact that the enemy held the Fushun coal mines.

It was (3) especially that prompted him to undertake an offensive movement.

According to Kuropatkin, the failure of the Shaho operations was due to—

(1). Stakelberg's want of skill ; the latter is alleged to have possessed a threefold superiority over the Japanese.

(2). The irresolute leading of generals commanding portions of the Western Detachment.

He recounts the views expressed by various Army Commanders at councils of war which took place between the Sha-ho fighting and Hei-keu tai.

The report on the latter battle reveals serious defects in reconnaissance and in intercommunication between commanders.

Many pages are devoted to a discussion of General Kaulbars' action at Mukden ; this officer is declared to be mainly responsible for the disastrous termination of the battle. Kuropatkin accepts a due share of the responsibility for failure, since he did not insist on the formation of a sufficiently strong strategic reserve, and did not attempt to prevent the mixing up of units. A perusal of the narrative clearly shows that the breaking up of tactical units was often resorted to without any necessity.

In the final pages he alludes to the advantage which the Japanese possessed in being able to replace losses so quickly. Their efficient system of espionage is ascribed partly to the sympathy (?) of the Chinese. The national enthusiasm for the war which prevailed in Japan is contrasted with the lukewarmness exhibited in Russia. The frequent suicides amongst Japanese prisoners of war are alluded to, and three instances are quoted of parties of Japanese suffering annihilation in preference to capture during the fighting at Mukden. On the other hand, many strictures are passed upon the conduct of Russian troops in action. During the latter portion of the Liao-yang fighting the hesitation of the men to advance through the high kaoliang near the right bank of the Tai-tsu-ho was one of the factors which induced the Russian commander to desist from offensive operations in this quarter.

In the report on the Sha-ho fighting unfavourable comment is passed on the unsteadiness of portions of one army corps and on the tendency of men to quit the ranks in order to succour wounded comrades. The unsatisfactory conduct of two army corps at Hei-keu-tai is likewise mentioned.

The orders and details regarding the disposition of the forces which are given in the appendices are based on carefully compiled official data. The text, too, contains much statistical information. At the beginning of the fighting around Liao-yang the Russian Army was 350 officers and 14,800 men short of its paper strength ; some companies had only 100 out of 220 bayonets On September 16th 670 officers were lacking. After the Sha-ho fighting 252 battalions mustered only 140,000 bayonets ; 2,700 officers were wanting, the average number per battalion being 11. At the beginning of 1905 the shortage of officers had risen to 5,600.

The Russian losses at Mukden are given as 2,118 officers and 89,352 others. On the morrow of the fighting 114 battalions of the II. and III. Army Corps averaged 144 bayonets each, but three days later the numerous stragglers who had rejoined raised this figure to 300 bayonets. The report clearly demonstrates the demoralization which pervaded the Russian forces at that time. In several portions of the book discussions occur as to the impossibility of offensive movements, despite the numerical superiority which is admitted in some of these instances. The passive tendencies of the directing authority are betrayed throughout the report.

The book contains no map, and as the transliteration of Chinese names differs considerably from ours, British readers of the book will often experience difficulty in identifying places.

Digitized by Google

GERMAN OFFICIAL ACCOUNT OF THE RUSSO-JAPANESE WAR (THE YALU). Authorized translation by K. von Donat. 258 pp., 9 appendices, including 5 photographs, 6 maps in pocket. 8vo. London, 1908. Hugh Rees. 10s. 6d.

This is a translation of the second of the series of monographs concerning the Russo-Japanese War prepared by the German General Staff. The first (of which no translation has hitherto appeared) dealt with the Siege of Port Arthur.

HISTORY OF THE ROYAL REGIMENT OF ARTILLERY. By Lieut.-Colonel H. W. L. Hime. 148 pp. 8vo. London, 1908. Longmans. 6s.

This book carries on the history of the Royal Regiment of Artillery from 1815, where the book by Colonel Francis Duncan left it, to 1853. It is therefore chiefly concerned with the wholesale reductions after the Napoleonic wars, and the subsequent increase of establishment due to the representations of the Duke of Wellington in 1847.

THE MILITARY MEMOIRS OF LIEUT.-GENERAL SIR JOSEPH THACKWELL, G.C.B., K.H. By Colonel H. C. Wylly, C.B. 424 pp., including appendices and index. 8vo. London, 1908. Murray. 15s.

This historical biograph is compiled from the diaries and correspondence of Sir Joseph Thackwell during the sixty years he spent in the Service, supplemented by carefully selected extracts from acknowledged authorities on the military events in which he was concerned. He served in the Peninsular War and was present at Waterloo. In that battle his superior officers were killed, and in the evening it devolved upon him to lead his regiment, the 15th Hussars, in a final charge upon a square of the Imperial Guard. Two horses had already been killed under him, and during this charge he was shot through the bridle hand; nevertheless he continued to lead the charge with the reins in his teeth until another bullet shattered his left arm and brought him to the ground. He was left all night where he fell, and the following day had his arm amputated. Within ten days he was however riding over the battlefield, and within a comparatively short space of time was hunting in France. The next service he saw was in Afghanistan in 1839, where he commanded the cavalry, and was fortunate enough to escape the horrors of the retreat from Kabul by being sent back to India after the rout of the Afghans at Ghuznee. He served in a similar capacity in the short campaign against the Mahrattas of Gwalior and in the war against the Sikhs in 1846.

During the latter, the victory of Sabraon was due in a large measure to his leading and the gallant conduct of the troops under his command, who, after the British infantry had been checked, resolutely attacked the entrenched enemy. In the Battle of Gujerat the cavalry again were mainly instrumental in obtaining the decisive victory which terminated the campaign.

At the age of seventy-three this gallant veteran tried hard, but without success, for a command in the Crimea.

As a record of a long and varied career this book is well worth reading, and not the least interesting feature is the picture it presents to us of a man of independent means with such high ideas of the obligations of a gentleman and a soldier that the whole of his life is devoted to military service, in which he carries out his duties in a punctilious and unselfish manner.

Digitized by Google

## POLITICAL.

FRANCE AND GERMANY. By Victor Meyn'er. 139 pp. 8vo. London, 1908. Sonnenschein. 2s.

This historical *précis* of the political relations between France and Germany covers the period from the Treaty of Frankfort in 1871 to the Algeciras Conference in 1906, but the greater portion of it deals with the events of the last four years.

It is a useful and concise account of the events leading up to the Algeciras Conference, but the reader must bear in mind that the author is evidently playing the part of prosecuting counsel against Germany; it will also be noted that no authority is as a rule given for the many emphatic statements that are made.

EUROPE AND THE OTTOMAN EMPIRE (L'Europe et L'Empire Ottoman). By R. Pinon. 603 pp., with 2 maps. 8vo. Paris, 1908. Perrin. 4s.

This valuable work by Monsieur René Pinon is of especial interest in view of the present crisis in the Near East.

The book is divided into twelve chapters. Commencing with a review of the evolution in modern times of the Near Eastern question, the author goes on to discuss the Black Sea and the question of the Straits. Four chapters are devoted to a consideration of the Macedonian question and are followed by chapters dealing with the rivalry of the Great Powers in the Ottoman Empire; the Tabah incident and the Arab question; the Austro-Serb conflict; the rise of Bulgaria and its present importance. The two succeeding and final chapters deal with French interests in the Near East.

## STRATEGICAL AND TACTICAL.

PREPARATION FOR WAR ON THE COAST (Kriegsbereitschaft an der Meeresküste). By Vice-Admiral Galster (retired). 19 pp. 8vo. Berlin, 1908. Verlag der *Neuen Revue*. 10d.

This article, a reprint from the *Neue Revue*, has been written with a view to bringing to notice the necessity for improving the North Sea coast defences for the better protection of the important commercial towns of Hamburg, Bremen, and Emden. The writer argues that the defence of the coast cannot depend on the action of the mobile fleet, but must be ensured by coast defences.

The works at Cuxhaven, he states, are insufficient for the protection of Hamburg. A subsidiary position further up the Elbe should be selected for the establishment of other works and minefields.

He points out that Great Britain has, according to him, most effectively protected her principal ports by strong defences all round the coasts of Great Britain and Ireland. In his enumeration of the British coast defences he takes into account the coast forts at Hythe and Eastbourne. It would seem probable that he lays undue importance on the value of the Martello towers.

The author further maintains that coast defences must be so strong as to make a hostile fleet chary of engaging them.

TACTICAL PRINCIPLES. By J. Bürde. 96 pp. 8vo. London, 1908. Rees. 3s. 6d.

The author traces briefly the changes in tactics from the time of Frederick the Great up to the present day, and describes the main causes which have rendered these changes necessary. He then goes on to consider the motives which actuate men on the field of battle, and enunciates eight chief tactical principles based on the most powerful of such motives, in the author's opinion, namely, the passion of revenge.

Digitized by Google

These eight principles are then discussed in detail, and many examples from campaigns are alluded to in support of them. To the majority of these principles no exception can be taken, but some require rather stronger arguments in support of them than Mr. Bürde has expressed in this short volume, before they can be accepted as they stand.

Perhaps the most valuable part of the book is the last half of it, and this is devoted to a discussion of the conditions which favour an extension of front. Frontages, he states, are dependent on two factors—the size of the force and the number of the communications—and the wide frontages employed in late wars were due to these causes and not to modern firearms.

Mr. Bürde has illustrated the discussions principally by means of imaginary examples and rough sketches, with the result that they are both lucid and brief.

His object is not to give an exhaustive treatise on tactics, but merely to throw light on tactical subjects. In this he has ably succeeded.

## TRAINING AND EDUCATION.

NOTES ON OPTICS. By H. J. Davidge, B.SC., M.I.E.E. 92 pp., with 72 figures. London, 1908. H.M. Stationery Office. 6d.

This is an altogether excellent little text book, and may be cordially recommended to any one desirous of acquainting himself with the elementary theory of ordinary optical instruments.

The various applications of the properties of light to simple optical instruments, with special reference to those used in the Service, form Part II. of the book. The optics of search lights, the sextant, the microscope, field-glasses and telescopes, optical gun sights, stereoscopes and range-finders, are described in the clearest manner. The book is well printed and adequately illustrated. It covers ground which is not, as far as we are aware, exactly covered by any previous publication, and meets a distinct want. It is one that should be in the hands of every officer whose duties involve the use of any optical instrument, and who desires to understand the nature of the tool he is employing.

NOTES ON TACTICS, FOR THE USE OF CANDIDATES AT THE STAFF COLLEGE (Causeries sur la tactique, à l'usage des candidats à l'École supérieure de guerre). 2nd edition. By Capt. Serret. 270 pp., with map. 8vo. Paris, 1908. Chapelot. 3s. 6d.

This book is intended for Candidates for the École supérieure de guerre; it comprises sixteen tactical problems, a short treatise on field fortification, and twenty-one exercises for the use of an instructor or examiner.

In each problem the General and Special Ideas are given on which the problem is based; then there is an elaborate study of the dispositions, beginning with the orders which would be given by the General of Division and General of Brigade. The various incidents which might occur in the carrying out of the orders are discussed, and the points which the officer who has to give orders should bear in mind, as well as the duties of the covering screen of cavalry, the artillery, etc. A map shows the scene of the imaginary operations described in the exercises, comprising the country to the north-west of Verdun.

NOTES ON STAFF RIDES AND REGIMENTAL TACTICAL TOURS FOR BEGINNERS. By Major T. E. Fowle. 26 pp. 12mo. London, 1908. Gale & Polden. 2s.

The second edition of this book, the first edition of which was published seven years ago. It deals briefly with the general object of Staff, Regimental, and Tactical Tours, and gives general instructions as regards the method of carrying them out. It concludes with notes on writing an appreciation of the situation and Notes on Reconnaissance. In both of these the author gives numerous headings, which may be useful to beginners, for whom the book is written, but which, if rigidly adhered to, are apt to lead to the inclusion of much unnecessary detail.

On the whole the book should prove useful to those for whom it is intended.

Digitized by Google

THE RUSSIAN MANUAL OF FIELD FORTIFICATIONS FOR THE INFANTRY. Official. 73 pp., many illustrations. 12mo. St. Petersburg, 1908. General Staff.

This is a portion of the first part of the new *Manual of Field Fortification for the Infantry*, and deals with the "Strengthening of Positions." The second and third parts will deal with "Communications" and "Troop Telephones." The completed manual will replace the text-book issued in 1891.

The volume is divided into two sections:—

(1). Instruction laid down for the private and lance-corporal.
(2). Instruction laid down for non-commissioned officers.

A third section, not yet published, will give instruction for the officer.

The first section contains forms of trenches, traverses, and shelters, and is written in such simple language that, with the help of the pictures, which are drawn in perspective, any soldier should be able to understand it without instruction.

The second part gives some instruction as to the siting of trenches, revetments, screening, shell-proofs, head-cover and loopholes, latrines, abatis, wire entanglements, deep military pits, utilization of walls, ditches and other existing cover, kitchens, and perspective views of two redoubts.

There is nothing new or remarkable in the volume. No pattern of fire trench with a low parapet is given, 20" being the lowest shown. Special attention is directed to digging lying down, the necessity for providing cover for the head and shoulders, and for conveniences—latrines, water-casks, ammunition recesses—in trenches. The deep military pits, to which the Japanese engineers say they owed many decorations, are retained.

The book is very short and the patterns simple as might be expected of an army with recent war experiences.

INSTRUCTIONAL LETTERS ON TACTICS (Taktische Unterrichtsbriefe). By Major-General Griepenkerl. 286 pp., with 4 maps. 8vo. Berlin, 1909. Mittler. 7s. 6d.

This is the 7th edition of the valuable work originally published by General Griepenker (then a captain) eighteen years ago. A new edition has been rendered necessary by the recent changes in German regulations, and notably by the issue of new Field Service Regulations and Training Manuals for Infantry and Field Artillery. The contents of the work are otherwise unchanged.

The 6th edition was translated and adapted to English organization by Capt. Maxwell under the title of "Letters on Applied Tactics." (Rees, 8s 6d.).

FORTIFICATION APPLIED TO SCHEMES. By Lieut.-Colonel L. J. Shadwell and Major W. Ewbank. 252 pp. 8vo. London, 1908. Rees. 10s. 6d.

The second edition of this book, written to aid candidates in their study of this subject for promotion. The first portion of the book consists of an amplification of the Manual of Military Engineering and of explanations how the calculations as to working parties, tools, material, etc., are arrived at and can be practically applied.

The rest of the volume, and by far the greater portion, is devoted to showing how the principles contained in the manuals should be applied to the solution of problems, and a selection of papers, both for the practical and theoretical examination, is given with solutions.

This book serves a useful purpose, as it enables candidates to direct their studies on the right lines, and goes thoroughly into the necessary details.

Digitized by Google

APPLIED TACTICS FOR EXAMINATION PURPOSES. By Capt. Demangel. 192 pp. 8vo. Yorktown, 1908. Bradford. 5s.

The second edition of this book, as its title denotes, deals with Applied Tactics solely from an examination point of view. It is a supplement to "Questions and Answers on Tactics" by the same author, and is intended to be read in conjunction with it.

Its value lies chiefly in calling attention to principles set forth in Combined Training and other text books, and showing how these affect the solution of problems on a map.

Diagrams illustrating the various examples quoted are not given, and without them it is somewhat difficult to follow the author's meaning.

THE MILITARY LAW EXAMINER. By Lieut.-Colonel G. C. Pratt. 317 pp. 8vo. London, 1908. Gale & Polden. 4s. 6d.

The seventh edition of this well-known publication.

ADMINISTRATION, ORGANIZATION, AND EQUIPMENT MADE EASY. By Lieut.-Colonel S. T. Banning. 265 pp. 8vo. London, 1908. Gale & Polden. 4s. 6d.

This is the eighth edition of this publication, revised and brought up to date by Capt. R. F. Legge.

MILITARY LAW MADE EASY. By Lieut.-Colonel S. T. Banning. 332 pp. 8vo. London, 1908. Gale & Polden. 4s. 6d.

A fourth edition of this book, brought up to date in accordance with recent text-books and Army Orders.

## FORTIFICATION AND MILITARY ENGINEERING.

ENGINEER FIELD MANUAL. Prepared under the direction of the Chief of Engineers, U.S. Army. 456 pp. and index. Numerous plates. 8vo. Washington, D.C., 1907. U.S. Government Printing Office.

The book is divided into six parts, viz. :—(I.) Reconnaissance; (II.) Bridges; (III.) Roads; (IV.) Railroads; (V.) Field Fortifications; and (VI.) Animal Transportation.

Though entitled a "Field Manual," the book gives considerably more detailed information than is customary in the "Field Manuals" issued to our army.

*Part I.*, dealing with "Reconnaissance," gives very detailed information, not only about military sketching, as understood in our army, but also about survey work in general, including a description of the construction, adjustment, and use of various instruments, such as a Field Level and Theodolite.

*Part II.*, entitled "Bridges," while giving various examples of temporary military bridges, at the same time gives much valuable information regarding stores and formulæ for the calculation of stresses in bridges of a more permanent nature.

*Part III.* deals with "Roads," and is devoted more especially to the repair of existing ones, as it is pointed out that, as far as roads are concerned, this will generally be the work which the Military Engineer will have to perform. Tables are included in this part for assisting in the calculation of the amount of earthwork necessary in repairing or constructing a road.

*Part IV.* is devoted to "Railways," about which much information is given regarding rolling stock, traffic management, and the laying out of a line of railway. Very little information is, however, given regarding rapid repairs to a railway.

Digitized by Google

*Part V.* gives various dimensions of field entrenchments, obstacles, etc., and the definition of terms used in connection with them.

A considerable portion of this part is given up to a description of military mining.

*Part VI.* includes a considerable amount of veterinary information, while at the same time giving some interesting notes on transport, and pack-transport more especially.

## AERIAL NAVIGATION.

GERMANY AND ENGLAND, PLAIN SPEAKING TO THE EMPEROR (Deutschland und England, ein offenes Wort an den Kaiser). By Regierungsrat R. Martin. 94 pp. 8vo. Hanover, 1908. Adolf Sponholtz Verlag. 1s. 6d.

This enthusiast on aerial navigation for military purposes, to be devoted to offensive uses against Great Britain, has already published two or three books dealing with the same subject, which have been noticed in this publication.

The author commences, in his introduction, with an appeal to the Kaiser to place the foreign policy of Germany on a sound basis, and to abandon ship building for air-ship construction, which is, in his opinion, the only means by which Great Britain can be brought to subjection.

He devotes a chapter to the question of the daily increasing danger of a general world war, and another to pointing out how England's geographical position as an island will cease to exist once Germany has command of the air, and that consequen ly the difficulties which Cæsar, William the Conqueror, and Napoleon had to contend with in the invasions by the two former and the contemplated invasion by the latter of Great Britain by sea will be eliminated from the problem.

After dealing fantastically with the manner in which an invading army of 200,000 could be landed in England by means of air-ships, he concludes his book semi-apologetically by arguing at some length that the very fact of Germany possessing the means to put this operation into practice will force Great Britain into an Anglo-Teutonic alliance, which would be entirely acceptable to Germany; for Mr. Martin maintains that the political and commercial interests of Great Britain in no way clash with those of the German Empire, and that the last thing desired in Germany is to see the dismemberment of the British Empire.

## BOOKS OF REFERENCE.

THE ARMY ANNUAL YEAR BOOK AND ALMANACK, 1908. Edited by Major F. S. Baden-Powell. 467 pp. 4to. London, 1908. The Army Press. 7s. 6d.

The first edition of this publication. It contains full information on the various methods of obtaining commissions in the Regular and Indian Army, Special Reserve, and Territorial Force, together with a full account of the new Territorial scheme from its origin.

Articles giving a brief account of Manœuvres and Campaigns of the year, and the lessons to be learnt from them; the policy on the North-West Frontier; recent progress in Aerial Navigation; and Machine-guns, are included.

In addition it contains details regarding an Army in the Field, the Indian Army, the year's Recruiting, and the Army Estimates, and concludes with a brief account of the Military career of the late Sir Redvers Buller, and of the Union Jack Club.

More than a quarter of the book consists of extracts from Regulations on Pay and Pensions, and Lists of Officers holding Staff Appointments at home and abroad.

The Establishments given are not quite up to date, but otherwise as a book of reference on the Military Service it should prove of value.

Digitized by Google

## TRAVEL AND TOPOGRAPHICAL.

TWENTY YEARS ON THE NORTH-WEST FRONTIER. By G. B. Scott (Survey of India). 272 pp., with 2 maps. Crown 8vo. Allahabad, 1906. Pioneer Press. 2s. 4d.

An interesting record of a surveyor's experiences among the Pathan tribes of the north-west frontier of India, beginning in the early sixties and ending with the Afghan War of 1878–80. The writer tells the story of the Ambela Campaign of 1863, and relates personal experiences in the Black Mountain Expedition of 1868 and the Afghan War. The account of the two Bazar Valley Expedi ions in 1879 and the chapter "Among the Mohmands" are of special interest in the light of recent events.

The book concludes with a chapter entitled "Can Russia invade India," in which the writer criticizes our past dealings with Afghanistan and gives his views as to the steps to be taken to secure India against the Russian menace.

## MISCELLANEOUS.

MARSHAL ALEXANDER BERTHIER AND HIS END (Marschall Alexander Berthier und sein Ende). By Dr. phil. Michael Strich. 127 pp. 8vo. Munich, 1908. Reusch. 3s.

Michael Strich has written this book partly with a view to supplementing Derrécagaix's recently published biography of Marshal Berthier, which he feels to be incomplete in one respect. The strategical services and military virtues of the great Chief of the Staff have been dealt with by Derrécagaix, Michael Strich maintains, with very commendable thoroughness, but the man Berthier has been passed over too briefly. This is particularly regrettable, he continues, as a psychological study of the Marshal affords an indispensable clue to the solution of the problem of his death.

Michael Strich gives a short narrative of the life of Alexander Berthier, combined with an exceedingly interesting character study of this remarkable man, who was Napoleon's constant and most trusted companion.

The final catastrophe, which was enacted at Bamberg on 1st June, 1815, is examined with minute care, the author having had access to the archives of Bamberg, Munich, Vienna, and Berlin. One is led irresistibly to the conclusion that Berthier caused his own death, and that it was not the result of an accident or the work of assassins, as has been averred. If further confirmation of this conclusion were needed, the psychological history of the great Chief of Staff, as narrated in this volume, would provide it abundantly

IS GERMANY SUPERIOR TO US? IMPRESSIONS FROM BEYOND THE VOSGES (Ist Deutschland uns überlegen? Eindrücke jenseits der Vogesen). By Major Driant (translated into German by Lieut. Hedler). 32 pp. 8vo. Berlin, 1908. Walther. 6d.

This work is a translation from the French. The author, Major Driant, a son-in-law of General Boulanger, has already given vent to a cry of alarm, when he published in 1906 a pamphlet entitled "vers un nouveau Sedan," which caused a considerable sensation at the time. He now again calls the attention of his countrymen to what he considers the superiority of the German Army, German character, and German institutions.

His opinions of the German Army were apparently chiefly derived from attendance at some Imperial manœuvres in Silesia. He quotes from conversations with German officers, who appear to think that they will some day go to war with France, but would much prefer to fight the English. The latter however, they say have unfortunately no army. But they (the English) must have troops on the Continent, and the French have been selected for this purpose. The German officers warned the Frenchman that his

Digitized by Google

country would get no help from England. England, they said, is the only country in Europe that does not fear war, as she has in the past always got other nations to do her fighting for her.

Major Driant's admiration of Germany and all things German is almost fanatical. Particularly does he contrast the slackness of discipline, the "Hervéism," and anti-militarism, which he asserts are rife in the French Army, with the order and strict discipline that obtain in the armed forces of the German Empire.

A NEW WÖRTH (Ein neues Wörth). By Major von Hoppenstedt. 238 pp., with 2 maps and 9 plans in the text. 8vo. Berlin, 1909. Mittler. 5s.

The author of this book has already penned another on the same lines, entitled "The Battle of the Future," which has attracted some attention in Germany, and was noticed in No. 1 of this publication.

"A New Wörth" is a graphic and spirited description of an imaginary battle fought under modern conditions on the original battlefield.

The element of reconnaissance by means of air-ships and the use of explosives from these aerostats are new factors which are introduced.

An interesting book.

THE BOOK OF WAR, THE MILITARY CLASSIC OF THE FAR EAST. Translated from the Chinese by Capt. E. F. Calthrop, R.F.A. 120 pp. 12mo. London, 1908. Murray. 2s. 6d.

As stated in a preface by the translator, this work still remains the most celebrated treatise on war in the literature of China. It is a collection of the sayings of Sun and Wu, two commanders who flourished about the 5th century B.C., and it is interesting to note how amongst these sayings are to be recognized many of the principles which at the present time are regarded as essential to success in war. *Moral* was even in those days recognized as of supreme importance; a commander is advised, as regards the passage of a river: "After crossing waters, pass on immediately to a distance." The health of the troops must be considered. As regards reconnaissance: "The rising of birds shows an ambush. Startled beasts show that the enemy is stealthily approaching from several sides. High, straight spurts of dust betoken that chariots are coming. Long, low waves of dust show the coming of infantry." A great deal of stress is laid upon the necessity, before giving battle, of an accurate knowledge of the enemy's condition, and for this purpose the use of spies is strongly advocated.

The book is one which will well repay perusal, although much of it is in the usual inconsequent Chinese style, of which the following is an example:- "Righteousness is overcome by propriety; might by humanity; revenge by words; tyranny by deception; unrighteousness by strategy."

LONG-DISTANCE RIDES (Dauerritte). By Veterinary Surgeon Dr. Heuss. 52 pp. 8vo. Berlin, 1908. Mittler. 1s. 6d.

The author enters very fully into the question of these exercises. He treats the subject under two main headings: preparation for the ride, and the method of carrying out the ride itself.

Under the first of these headings the selection of the class of horse to employ, the conditioning and training of the animal, and shoeing are carefully gone into. Opinion, in Germany at any rate, seems to favour half-bred horses for the purpose. The execution of the ride includes division of the distance and the nature of pace, feeding and watering, etc.

The natures of disease resultant on long-distance riding, and the measures to be taken with reference to treatment of the horse on completion of such an exercise, are also dealt with.

Digitized by Google

# THE HELLIWELL
# PATENT "PERFECTION" GLAZING.

**ADVANTAGES.**

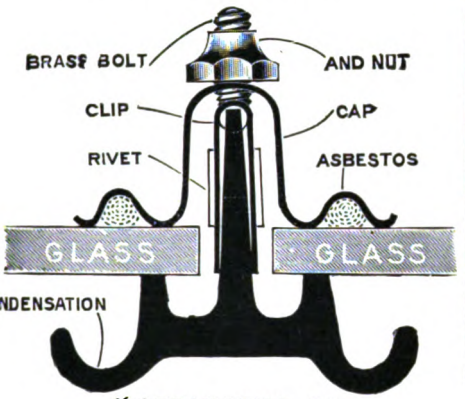
No Putty. No Paint.

Guaranteed Water-tight and Dust Proof.

Easily Repaired.

Planks laid in Safety across Caps.

Steel Bars galvanized; and also entirely covered with Lead to prevent Corrosion.




"ORDINARY" BAR.
"Ordinary" Section.
BARS of different strengths, to carry up to 12ft. without Purlin.
CAPS in either Copper, Zinc, or Lead.

**EXTENSIVELY USED BY**

H.M. Government, for Barracks, Dock Sheds, Post Offices, Stores, etc.

All the leading Railway Companies.

Municipal Authorities, for Markets, Baths, Libraries, Art Galleries, Schools, etc.

Also for every kind of Glass Roofing.

Head Office and Works: **HELLIWELL & CO., Ltd.,**
London Office: 11, Victoria Street, Westminster, S.W. **BRIGHOUSE, YORKS.**

# RUBEROID!
# ROOFING!

A High Grade Permanent Roofing Material in general use for all classes of Buildings. Its light weight as compared with other roof coverings makes it particularly useful where long transport of building materials is necessary.

Quarters of the Malay States Guides, Sepoy Lines, Penang, covered with Ruberoid.

Full particulars of cost and shipping weights gladly supplied. Our Illustrated Catalogue, No. 39, and samples sent post free on application.

**THE RUBEROID COMPANY, Limited, 81 & 83, Knightrider St., LONDON, E.C.**


Digitized by Google

SPECIFY

# INDENTED STEEL BARS

FOR YOUR

## *Reinforced Concrete Work,*

And you will obtain HIGHEST POSSIBLE STANDARD OF EFFICIENCY, combined with GREATEST POSSIBLE ECONOMY.

**NO ROYALTIES TO PAY.**

Head Office :—

**QUEEN ANNE'S CHAMBERS, LONDON, S.W.**

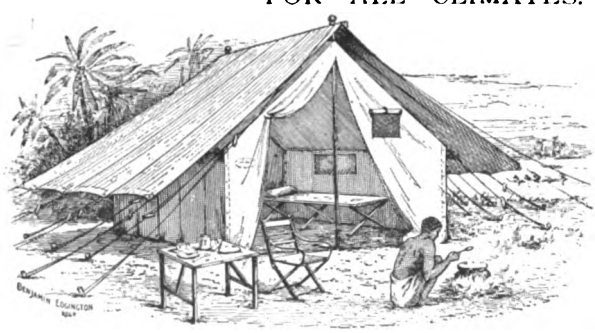
Branches all over the United Kingdom.

TELEGRAMS :—"PATINBAR, LONDON."

# BENJAMIN EDGINGTON'S

# Tents & Camp Equipment

FOR ALL CLIMATES.



**TENTS.**
**CAMP FURNITURE,**
**CANTEENS.**

**Air and Water-tight Uniform Trunks.**

**DECK CHAIRS.**

**Clothing and Personal Outfit.**

**Double-Roof Ridge Tent,** as supplied for all the principal Surveys, Boundary Commissions, Railways, etc., in East and West Africa, and other parts of the World.

WRITE FOR TRAVELLERS' CATALOGUE.

**BENJAMIN EDGINGTON** (S. W. Silver & Co., and Benjamin Edgington, Ltd.),

**2, Duke Street, London Bridge, London, S.E.**

Telegrams :—"BENJAMIN EDGINGTON, LONDON."

Digitized by Google

# THE JOURNAL OF THE ROYAL ARTILLERY.

THIS Journal, which was formerly known as the "Proceedings" of the R.A. Institution, contains articles and information on Artillery matters, some highly technical and some general. Articles on general Military topics also appear.

In the Translations and Précis, which are an important feature, an attempt is made to keep up with the progress of Artillery on the Continent.

All members of the Royal Artillery Institution receive the Journal.

Any officer serving in the Navy, Army, Militia, Imperial Yeomanry, Volunteers and Colonial Permanent Forces can receive this Journal post free on application to the Secretary, R.A. Institution, at an annual subscription of 20s.

**WOOLWICH: ROYAL ARTILLERY INSTITUTION.**

**Agents: DULAU & CO., 37, Soho Square, London, W.**

**Single Copies, price 2s. 6d. each, postage extra.**

Sole Advertisement Contractor, **Mr. C. Gilbert-Wood,** Dacre House and Granville House, Arundel Street, Strand, W.C.

*Telegrams:* "GILBERWOOD, LONDON." *Telephone:* 4680 Gerrard.

## PROFESSIONAL PAPERS OF THE CORPS OF ROYAL ENGINEERS.

FOURTH SERIES.—VOL. I., 1905.

| | | | |
|---|---|---|---|
| PAPER | I. | **Simple Tunnel Work on the Mari-Attock Railway, Panjab,** by Capt. H. E. C. Cowie, D.S.O., R.E. | 1s. |
| ,, | II. | **Long Span Bridges,** by Max am Ende, M. INST. C.E. | 1s. 6d. |
| ,, | III. | **Recent Works in the N.W. Frontier Province, India** (Fortified Posts, Roads, Bridges, Civil Buildings), by Bt.-Col. G. K. Scott-Moncrieff, C.I.E., R.E. | 3s. 6d. |
| ,, | IV. | **Armoured Trains,** by Capt. H. O. Mance, D.S.O., R.E. | 3s. 6d. |
| ,, | V. | **Reinforced Concrete,** by Lt.-Col. J. Winn, late R.E. | 2s. 6d. |
| ,, | VI. | **Fortress Warfare,** by Capt. Moritz Ritter von Brunner. 9th edition of the work originally written by Field Marshal von Brunner. Translated by Capt. C. Otley Place, D.S.O., R.E. | 3s 6d. |
| ,, | VII. | **Fortresses and Military Engineering in Recent Literature.** No. 43 of the "Mitteilungen des Ingenieur-Komitees." Translated by Capt. F. A. Buzzard, R.F.A. | 5s. |

VOL. II., 1908.

| | | | |
|---|---|---|---|
| PAPER | I. | **The Theory of Arched Masonry Dams,** by Capt. A. ff. Garrett, R.E. | 1s. 6d. |
| ,, | II. | **Report on Mechanical Road Transport for India,** by Capt. E. N. Manley, R.E. | 2s. |

The price of separate Papers as above, in paper wrappers, is net.

They may be obtained from Messrs. W. & J. MACKAY & Co., LTD., Chatham, or from any Bookseller.


Digitized by Google

## "ANCHOR" LINE.

## Passenger and Cargo Services.

LIVERPOOL to BOMBAY & KARACHI (*viâ* Bombay). Fortnightly.

LIVERPOOL to CALCUTTA. Fortnightly.
**All Vessels call at Egyptian Ports.**

Large New Steamers. Splendid Accommodation for Passengers. Electric Light and Fans. Excellent Cuisine. Every Comfort. Moderate Fares, both Single and Return

Apply—"ANCHOR" LINE (Henderson Brothers), Ltd., Liverpool, London, Glasgow, &c.

## Nippon Yusen Kaisha.

Japan direct from London in 47 days, calling at COLOMBO, SINGAPORE and HONG KONG, by fast steamers fortnightly.
WAKASA MARU, 6,265 tons, March 6.

**To Japan, £54, 1st Class; £37 10s., 2nd Class; to other Ports at equally moderate rates.**

HIRANO MARU, *viâ* Marseilles, 8,520 tons, March 13. Fares on application.

ROUND THE WORLD, £107.

For Fares, etc., apply at—

**4, LLOYD'S AVENUE, LONDON, E.C.**

## Institution SILLIG,

**BELLERIVE, VEVEY, SWITZERLAND.**

**ESTABLISHED IN 1836.**

A HIGH-CLASS SCHOOL for the education of Boys in Classical, Scientific, Military, and Commercial Subjects, and for General, Moral, Mental, and Physical Development.

PRINCIPAL:

**MAX SILLIG—DE VALLIÈRE.**

## THE ARMY SCHOOL,

**Near MAIDENHEAD**

(Approved by the Army Council).

Head Master:

E. G. A. Beckwith, M.A. Oxon.

*(Late Exhibitioner of Winchester and Magdalen College).*

"A small public school in which boys from the age of twelve are prepared for the Army. The school buildings include a chapel, large dining hall, swimming bath, gymnasium, chemical and physical laboratories, besides 30 acres of playing ground."

SUCCESSES, 1907—1908.
Woolwich—One.
Sandhurst—Thirteen.
Qualifying Certificates—Sixteen.
Leaving Certificate—Five (Three Woolwich).

For FEES, etc. (reduced for Sons of Officers), apply to the Head Master.

## NAVIGAZIONE GENERALE ITALIANA.

The fine steamers "R. RUBATTINO" and "D. BALDUINO" sail alternately from GENOA TO BOMBAY on the 18th of each month, at 2 a.m.

FARES: 1st Class, £40 & £33; 2nd Class, £27 10s.; 3rd Class, £11.

GENOA TO ALEXANDRIA every Saturday, at 9 p.m.

NAPLES TO PALERMO every Evening, at 7.25 p.m

For Tickets and Berths apply to the Co.'s Agents—

**ALFRED LAMING & CO., 8, Leadenhall Street, E.C.**

## NOTES FOR THE TACTICAL FITNESS EXAMINATION,

With Sample Schemes and Solutions,

By Major A. T. MOORE, R.E.

PRICE
TWO SHILLINGS AND SIXPENCE.
Post 3d. Extra.

Obtainable from the Secretary, R.E. Institute, Chatham, and Rees, Limited, 119, Pall Mall, S.W.

# HAWKES & CO., LTD.,

TAILORS AND MILITARY OUTFITTERS, CAP AND ACCOUTREMENT MANUFACTURERS,

14, PICCADILLY, LONDON.

*Patronized by many Officers of the Royal Engineers.*


Digitized by Google

SOME PUBLICATIONS BY

# THE ROYAL ENGINEERS INSTITUTE.

| Title and Author. | | | Net Price to Non-Members. |
|---|---|---|---|
| | | | s. d. |
| **R.E. Field Service Pocket-Book.** 2nd Edition | 3″ × 5″ | 1902 | 5 0 |
| **The Destruction of Mosquitos,** being an Account of the Drainage and other works carried out with this object during 1902 and 1903 at St. Lucia, West Indies, by Major W. M. Hodder, R.E. | | 1904 | 2 6 |
| **Notes for Officers Proceeding to India.** Compiled by Major A. T. Moore, R.E. (Part I. Outfit, Servants, Amusements, Health, Hints for Ladies, etc.; Part II. Physical Features, Administration, Native Army, History, Languages, Castes, Religions, etc.; Appendix. Shooting Hints) | | 1904 | 2 6 |
| **Detailed History of the Railways in the South African War, 1899—1902.** 2 vols. (Vol. I. Organisation, Military Control, Working and Repair of Cape and Natal Government Railways; Management, Engineering and other Departments of Imperial Military Railways; Railway Pioneer Regiment; Organisation, Equipment and Use of Armoured Trains; Army Labour Depôts; pp. xli. and 275. Vol. II. 61 Photos and 93 Drawings) | Folio | 1904 | 42 0 |
| **The Franco-German War, 1870—1871.** Condensed from the German of Major J. Scheibert, and translated by Major J. A. Ferrier, D.S.O., R.E., and Mrs. Ferrier | | 1894 | 7 6 |
| **The Principles of Structural Design,** by Major G. K. Scott-Moncrieff, R.E., Assoc. Inst. C.E. 2 vols. (663 pp.; 30 Plates and numerous Figures) | | 1897 | 10 6 |
| **The Water Supply of Barracks and Cantonments,** by Major G. K. Scott-Moncrieff, R.E., Assoc. Inst. C.E. (311 pp.; 60 Plates and numerous Figures) | | 1896 | 10 6 |
| **Notes on Blacksmith's Work,** by Major R. F. Sorsbie, R.E. | | 1903 | 4 6 |
| **History of the Corps of Royal Engineers,** by Major-Gen. Whitworth Porter, R.E. 2 vols. | 9″ × 5½″ | 1889 | 7 6 |
| **Professional Papers of the Corps of Royal Engineers.** Occasional Papers Series. Vols. I. to XXX., 1877—1904. (Separate Papers at various prices) | each volume | | 10 6 |
| Fourth Series. Papers 1 to 7, 1905—1907; Papers 1 and 2, 1908. (Royal Octavo, 9″ × 6″). Various prices. | | | |

Except where otherwise stated, the books are octavo, measuring 8½″ × 5½″.
They may be obtained from Messrs. W. & J. Mackay & Co., Ltd., Chatham, or from any Bookseller.

**All communications concerning Advertisements in this Journal should be addressed to the SECRETARY, R.E. Institute, Chatham.**

**Telegraphic Address - "Sapper, Chatham."**

Digitized by Google

The McKenzie, Holland, &
Westinghouse Power Signal Co., Ltd.

# POWER SIGNALLING

Electro-pneumatic,
all-electric, and
automatic signalling.

Address:

**58, VICTORIA STREET, LONDON, S.W.**

Telegrams: "POWERSIG, LONDON." Telephone: 890 Westminster.

PORTLAND CEMENT.

# CONCRETE FIRE-PROOF SLABS.

For Internal and External Walls.
As cheap as any other, with the following advantages:—

**ECONOMY OF SPACE, GOOD KEY FOR PLASTER TILING, ETC., NO PLUGGING, AND SETTING COAT OF PLASTER ONLY REQUIRED.**

*For Particulars and Prices apply to:*

**THE ACTON CONCRETE PATENT PARTITION CO., 1909, Ltd.,**

Telegrams: "KONKREET, LONDON."
Telephone: 6294 AVENUE.

**63, CORNHILL, LONDON, E.C.**

# THE OFFICE FOR OFFICERS.

**LIFE ASSURANCE.** Specially designed for the Services.
**CONVENIENTLY PAID FOR** by Bankers' Orders (Monthly Premiums if desired).
**NO MEDICAL EXAMINATION** up to £500, in ordinary circumstances.
**LOANS AND SURRENDER VALUES.** Liberal and easy conditions.
**EXCEPTIONALLY GOOD TERMS** for War Risks and Foreign Residence.

Call or write for new Service Prospectus.

**Royal Exchange Assurance,** (Incorporated 1720.)
West End Office: 44, PALL MALL, S.W.

Digitized by Google

# THE ROYAL ENGINEERS JOURNAL.

Vol. IX. No. 4. APRIL, 1909.

## CONTENTS.


| | | Page. |
|---|---|---|
| 1. | **Aeroplanes.—A Short Account of some of the Present-Day Aeroplanes, and Motors for Aeronautical Purposes.** By Lieuts. W. D. Beatty and A. D. de R. Martin, R.E. (*With Photos*) ... ... ... ... ... | 245 |
| 2. | **Notes on the Employment of Sappers on the Works.** By A Company Officer ... | 261 |
| 3. | **Some Possibilities of Modern Forms of Transport.** By Capt. R. Walker, R.E. | 269 |
| 4. | **The Main Underground Telegraph System of Great Britain** (*continued*). By Major W. A. J. O'Meara, C.M.G., late R.E. ... ... ... ... | 281 |
| 5. | **The R.E. Headquarter Mess** (*continued*). By Lt.-Col. B. R. Ward, R.E. ... | 297 |
| 6. | **Memoir:**—Lieut.-General James Crofton. By Major W. Broadfoot, late R.E. ... | 303 |
| 7. | **Transcript:**—An Appreciation of Austria-Hungary's Military Position. (Translated from the *Neue Militärische Blätter* by Capt. E. G. Wace, R.E.). (*With Map*) | 307 |
| 8. | **Notices of Magazines** ... ... ... ... ... ... | 315 |


CHATHAM:
Royal Engineers Institute.
TELEGRAPHIC ADDRESS: SAPPER, CHATHAM.
Agents and Printers: W. & J. Mackay & Co., Ltd.

PRICE: 1s. 6d. POST FREE. ANNUAL SUBSCRIPTION: 15s. PAID IN ADVANCE.

Digitized by Google

THE MODERN ROOFING MATERIAL,

# "ETERNIT."

ROOFING SLATES.

SHEETS FOR WALLS AND CEILINGS.

INDESTRUCTIBLE, LIGHT, ARTISTIC, ECONOMICAL, WEATHERPROOF.

Weight, 22 lbs. Laid.

## G. R. SPEAKER & CO.,

**Engineers & Contractors to H.M. Government,**

**29, MINCING LANE, E.C.**

WIRE—"ETRASHEET." 'PHONE—CENTRAL 13174.

# Norfolk House School,

## BEACONSFIELD, S. BUCKS.

**Special Terms to Sons of R.E. Officers.**

**Prepares Boys from 7 to 14 years of age for Public Schools and the Royal Navy.**

THE School House, recently built, with all the latest improvements, stands 500 feet above sea level, on a gravel soil. It is one mile from Beaconsfield Station, whence there is a good service to London in 35 minutes.

Recent honours gained, include Scholarships,

**MARLBORO' (3), CHARTERHOUSE, FELSTEAD, ALDENHAM, HIGHGATE, AND NAVAL CADETSHIP. . . . . .**

Two £30 Scholarships offered yearly to intelligent boys likely to gain Public School Scholarships or Naval Cadetships.

Prospectus, Names of Scholars, and full particulars from

**Head Master, C. T. MARCON, M.A.**

Digitized by Google

Telegrams—"GUNDRADA, LONDON." Telephone—4716 Gerrard.

Fire, Theft and Burglary *(Combined)*.

THE ARMY, NAVY AND GENERAL ASSURANCE ASSOCIATION, LIMITED

HEAD OFFICE:- 217, PICCADILLY (CIRCUS), LONDON, W.

Chargers, Hunters, Marine Risks.

# The "Professional" Policy

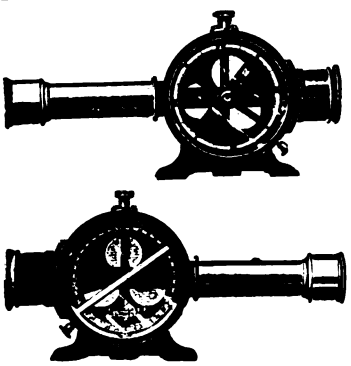
. of .

# Accident and Disease Insurance

Is Specially adapted for Military and Naval Officers serving in ANY PART of the WORLD, and now covers 30 Specified Diseases.

**Revised Prospectus of Extended Benefits on application—**

**217, PICCADILLY (CIRCUS), LONDON, W.**



## C. F. CASELLA & CO.,

MAKERS OF

***Surveying & Scientific Instruments***

To the Admiralty, Ordnance and all Home Departments, and to the Indian, Colonial and Foreign Governments.

**The Illustrations depict CASELLA'S ALTAZIMUTH, a convenient instrument for rough survey work of all kinds.**

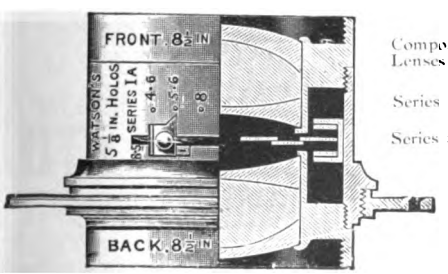
WRITE FOR PRICE LISTS.

**11-15, ROCHESTER ROW, Victoria St., LONDON, S.W.**

## THE FINEST PHOTOGRAPHIC LENS

— IS —

# THE HOLOSTIGMAT




*(WATSON CONRADY SYSTEM).*

Composed of two Anastigmatic and Achromatic Single Lenses of perfect correction for use as separate Lenses.

MADE IN THREE SERIES.

Series I. Aperture f6 Components f11·5. A perfect Lens for universal use.

Series IA.—Aperture f4·6. Components f8·5. For rapid work in dull weather.

Series W.A.—Aperture f11. Components f16. The ONLY convertible wide angle Lens made.

Price List sent FREE, on application by—

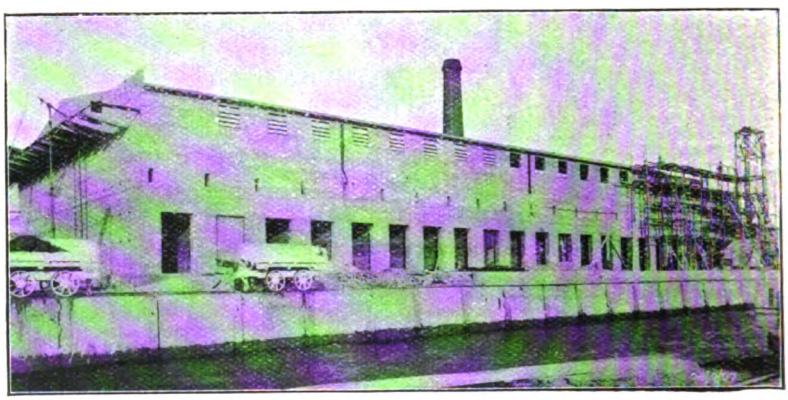
**W. WATSON & SONS, Ltd.,**

313, HIGH HOLBORN, LONDON

Digitized by Google

# EXPANDED METAL

## SYSTEM OF
## REINFORCED CONCRETE
## AND
## FIRE-RESISTING CONSTRUCTION.



EXPANDED STEEL CONCRETE CEMENT STORE FOR THE WOULDHAM CEMENT CO., LTD., WORKS, WEST THURROCK.

### Specialities:—

**CONCRETE REINFORCEMENT**; 3-in. mesh weights Expanded Steel for Foundations, Walls, Floors, Roofs, Bridges, Reservoirs, Sewers, Conduits, Hoppers, Silos, etc.

**LATHING FOR PLASTER**; Expanded Metal Lathing for Ceilings, Partitions, Exterior Walls, Steel Work Encasing, etc.

**MADE-UP GOODS**; Openwork Partitions, Fencing, Clothes and Tool Lockers, Machinery and Tree Guards, etc.

*Full particulars on application to:—*

## THE EXPANDED METAL CO., LTD.,

**YORK MANSION, YORK ST., WESTMINSTER, S.W.**

**Telegrams:—"DISTEND, LONDON."** **Telephones:—819 Gerrard; 1514 Victoria.**


Digitized by Google

# PATENT VULCANITE ROOFING

FOR

FLAT ROOFS, CONCRETE ROOFS
AND WOOD ROOFS.

## ROOF TANKS

FOR

SWIMMING-BATHS, RESERVOIRS, BRIDGES.

**EFFICIENT AND ECONOMICAL.**

**For Waterproofing Existing Faulty Concrete and Asphalte Roofs.**

Will give with the movements of the building due to settlement, vibration, and expansion and contraction, and is guaranteed for long periods.

Special surfaces can be provided to the Vulcanite covering to meet any special requirements.

*Full particulars on application to:—*

**VULCANITE, LIMITED, 118, Cannon St., London, E.C.**
**Laganvale, Belfast,** and at **MANCHESTER.**

(Also Manufacturers of VULCANITE and BITUMEN Sheetings for the Sloping Roofs of Light Buildings, and for use as a Damp-proof Course).

# BULLIVANT & CO., Ltd.,

Manufacturers of

## *STEEL WIRE ROPES*

FOR

CRANES, LIFTS, HOISTS, SUSPENSION BRIDGES, HAULING, Etc.

**DURABLE AND RELIABLE.**

Contractors for . . . .

## AËRIAL ROPEWAYS

Specially designed for conveying Stores, Munitions, etc., across Rivers, Ravines, etc. Can be quickly and easily erected and dismantled. Suitable also for conveying Passengers.

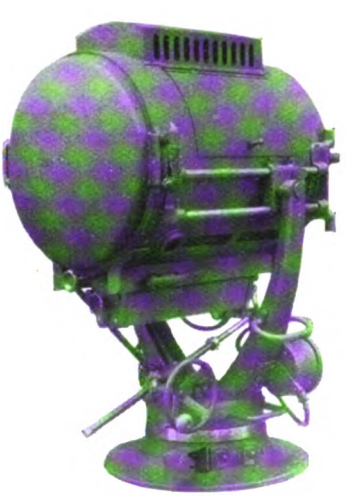
**BLOCKS, PULLEYS, TACKLE, AND ALL WIRE ROPE APPLIANCES.**

Regd. Office, **72, Mark Lane, London, E.C.**
Works, **Millwall, E.**

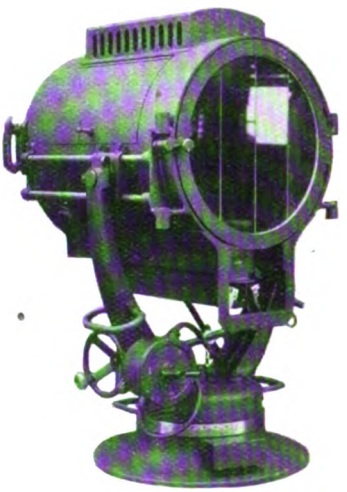

Digitized by Google

# SIEMENS
# Searchlight Projectors.

**MADE IN ALL SIZES FROM 25 cm. to 200 cm.**



BACK VIEW.



FRONT VIEW.

**35-CENTIMETRE FIELD SEARCHLIGHT.**

---

Projectors can be fitted with Siemens Patent Horizontal Automatic and Hand Lamp, or Horizontal Lamp for hand feed only. Mirrors of the metallic or glass parabolic type. Single or double Dispersing Lenses. Iris Diaphragm Shutter or Venetian Louvred Signalling Shutter. Electric Control is fitted for Fortress, Battleship, and other use, if desired.

**Full Particulars on Application to M Department.**

---

## SIEMENS BROTHERS DYNAMO WORKS LTD.,

**Caxton House, Westminster, S.W.**

Telephone : GERRARD 860. Telegrams : "SIEMBRALOS, LONDON."


Digitized by Google

# CONTENTS.


PAGE.

1. AEROPLANES.—A SHORT ACCOUNT OF SOME OF THE PRESENT-DAY AEROPLANES, AND MOTORS FOR AERONAUTICAL PURPOSES. By Lieuts. W. D. Beatty and A. D. de R. Martin, R.E. (*With Photos*)... ... ... ... 245

2. NOTES ON THE EMPLOYMENT OF SAPPERS ON THE WORKS. By A Company Officer ... ... ... ... ... ... ... .. ... ... 261

3. SOME POSSIBILITIES OF MODERN FORMS OF TRANSPORT. By Capt. R. Walker, R.E. ... ... ... .. ... ... ... ... ... ... ... 269

4 THE MAIN UNDERGROUND TELEGRAPH SYSTEM OF GREAT BRITAIN (*continued*). By Major W. A. J. O'Meara, C.M.G., late R.E. ... ... ... ... ... 281

5. THE R.E. HEADQUARTER MESS (*continued*). By Lt.-Col. B R. Ward, R.E. ... 297

6. MEMOIR :—

Lieut.-General James Crofton. By Major W. Broadfoot, late R.E. ... .. 303

7. TRANSCRIPT :—

An Appreciation of Austria-Hungary's Military Position. (Translated from the *Neue Militärische Blätter* by Capt. E. G. Wace, R.E.). (*With Map*) 307

8. NOTICES OF MAGAZINES : –

*Bollettino della Societa Aeronautica Italiana.* By 'J.E.C.' ... .. ... 315
*Internationale Revue über die gesamten Armeen und Flotten.* By 'M.' ... 316
*Journal des Sciences Militaires.* By Lieut. H. L. Woodhouse, R.E. ... 320
*Le Bulletin.* By 'E.R.' ... ... ... ... ... ... ... .. 323
*Revue du Génie Militaire.* By Capt. J. E. E. Craster, R.E.... ... ... 325
*Revue Militaire des Armées Étrangères.* By 2nd Lieut. A. H. Scott, R.E.... 326

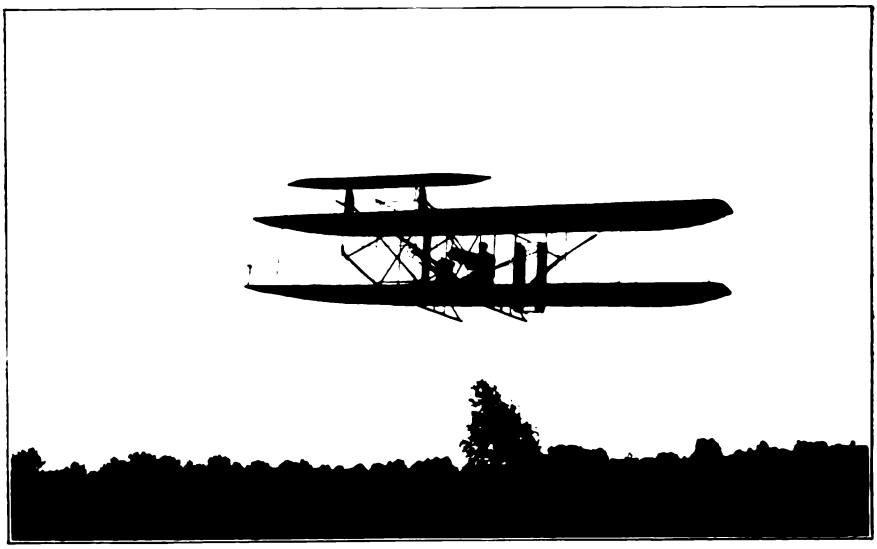

*Authors alone are responsible for the statements made and the opinions expressed in their papers.*

Digitized by Google

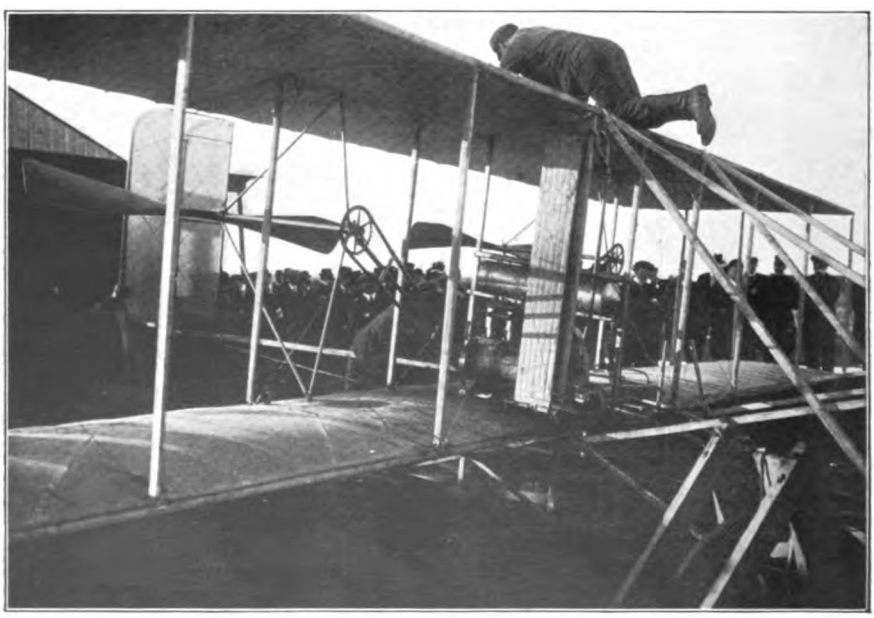
Digitized by Google

Digitized by Google

# AEROPLANES.



Wright flying at Le Mans.



Wright adjusting his vertical rudder.

*Photos copyright by M. Rol, Paris.*

Digitized by Google

# *AEROPLANES.*

*A SHORT ACCOUNT OF SOME OF THE PRESENT-DAY AEROPLANES, AND MOTORS FOR AERONAUTICAL PURPOSES.*

*By* Lieuts. W. D. Beatty and A. D. de R. Martin, R.E.

Owing to the recent rapid progress in aerial navigation numerous periodicals dealing with this subject have come into existence. It is probable however that some of the information contained in this article will be new to most of the readers of the *R.E. Journal*, as much of it has been obtained from personal inspection of the various machines.

The most successful aeroplanes at present are those of the Voisin and Wright types.

Voisin Aeroplanes.—MM. Voisin Frères have an aeroplane factory at Billancourt, a suburb of Paris. Their machines are all very similar in methods of construction, and vary chiefly as regards the number of planes and position of rudders. The aerofoil* consists of two or more supporting planes, with the ends—as a rule—and two or more partitions covered with canvas, thus dividing the body into several compartments. The tail is of similar construction and contains the vertical rudder, or both vertical and horizontal rudders if the screw is used as a tractor, as in the Goupy type. The tail is connected to the body by a light framework, which in some cases is open and in others covered in.

These aeroplanes are known to the public under the name of the aeronaut using them, *i.e.*, Farman, Delagrange, Goupy, Moore-Brabazon, etc.

The following is a description of an aeroplane used by Farman; this is a biplane machine, but it is understood that he has on occasions converted it to a triplane.

The body is of wood framework, covered on the top, bottom, ends, and two partitions, with a specially prepared waterproof canvas made by the Continental Tyre Company. This canvas is very similar to

* Aerofoil (Lanchester), from the Greek, lit., "An air-leaf," denoting the organ of sustentation of a gliding or soaring machine.

Digitized by Google

that used for canoe sails. The vertical and horizontal pieces of the framework are of ash, very carefully chosen, so as to be free from knots and to have the grain running lengthwise in each piece. The joints are made with aluminium compound brackets.

The whole framework is stiffened by cross ties of light piano wire.

The ribs in the supporting surfaces are of poplar, weigh about $1\frac{1}{4}$ lbs. each, and are spaced 18″ apart. The canvas on the ends and partitions is laced to the framework with whip cord and stiffened with slats similar to those used in a yacht's sails. All ribs and slats are covered with canvas on both sides, so as to avoid projecting surfaces and diminish resistance.

The supporting surfaces are formed to a curve—fore and aft—similar to that of a bird's wing, the camber being about 4″ at 18″ from the front edge in the length of 7′, and diminishing from this point to *nil* at the back and front.

In the Goupy type the ribs of the main planes are fixed at an angle to the uprights, so that when the machine is horizontal, the planes are set at a lifting angle of about 1 in 10.

The dimensions of the body are given in *Figs.* 1 and 2.

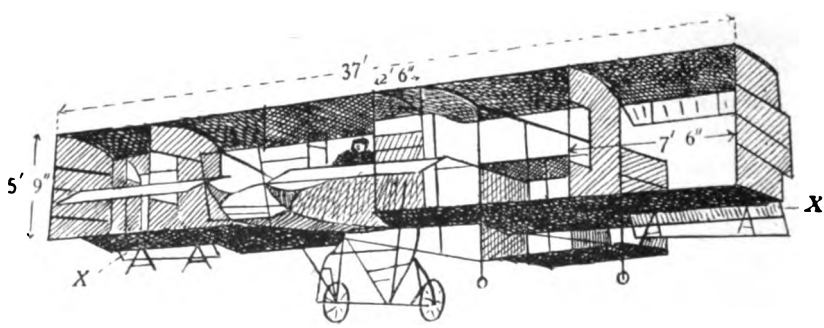



FIG. 1.—*Voisin (front view).*

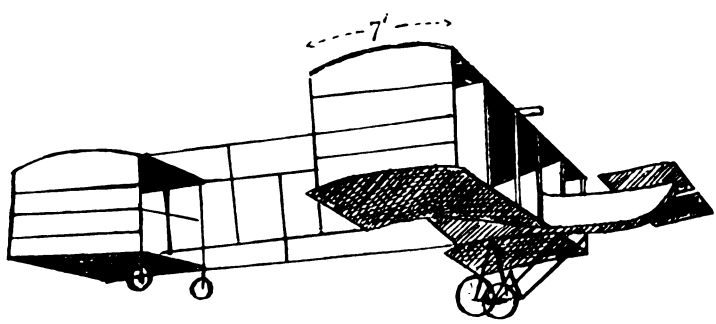



FIG. 2.—*Voisin (side view).*

Digitized by Google

The tail is of a total length of 22′ and consists of a box of similar construction to the body—8′ wide, 6′ long, and 5′ 6″ high—attached to the body by a light wooden framework, which in some cases is covered with canvas and in others left open. In the centre of this box tail is the vertical rudder, a wooden framework, canvas covered, 4′ 6″ high and 4′ wide, pivoted 1′ from the front. In some designs this rudder projects about a foot behind the tail, in others it only reaches to the back edge. It is actuated by turning the steering wheel and thus pulling cords attached to it.

The horizontal rudder is in front of the body of the machine, and consists of two planes—curved in the same proportion as the supporting surfaces—each 7′ by 3′, pivoted at about 7″ from the front edge on a $1\frac{1}{4}$″ steel tube. It is supported by a light wooden framework, projecting 7′ 6″ from the front of the body, and covered in with canvas. This rudder is actuated by pushing or pulling the steering wheel.

*Chassis.*—There are two spring-mounted castor wheels under the front corners of the box tail.

Under the body of the aeroplane is a framework of steel tubing, on which the body rests supported by long spiral springs. To this framework are attached two pneumatic-tyred castor wheels. Thus, if the aeroplane is caught by a side wind when on the ground it naturally moves round head to wind, and so avoids severe strains or capsizing.

The weight of the chassis is about 110 lbs.

The motor in this case was of the Antoinette type; in other machines Gobron Brillée, Vivinus, etc., are used. Weight, 265 lbs.; horse-power, 50; revolutions, 1,100. There is one direct-driven screw in this case, a propeller situated behind the body—diameter about 8′, effective pitch 7′ 6″.

In some of the Voisin machines the screw is used as a tractor and placed in front of the body, in which case the horizontal rudder is contained in the box tail.

When the screw is a propeller the engine is at the back of the body and the aeronaut in the front; when it is a tractor the positions are reversed.

The total resistance to flight of this machine is about 225 lbs.

| | |
|---|---|
| Weight complete with aeronaut ... | 1,500 lbs. |
| Area of supporting surfaces ... ... | 535 square feet. |
| Area of vertical surfaces... ... ... | 255 square feet. |
| Speed ... ... ... ... ... | 45 miles per hour. |
| Gliding angle ... ... ... ... | about 8° or 9°. |

*Longitudinal Stability.*—This is claimed to be automatic, but it is

Digitized by Google

difficult to say if this is the case, as it is also under control of the aeronaut by means of the horizontal rudder.

*Lateral Stability.*—This is automatic. With regard to this, when an aeroplane is rounding a corner the higher speed of the outer edge tends to raise that edge and so give automatic banking. If this lifting goes too far the aeroplane capsizes, or falls inwards towards the centre of the curve.

At present—when this article was written—Farman's machine could only turn slowly and with wide curves for fear of capsizing, as there was no means by which the aeronaut could assist the lateral stability.

It is understood that he is now experimenting with some additional movable planes, by which he can increase the resistance to flight of one side of the body while diminishing that of the other, and thus counteract the "banking" effect. The planes shown at XX in *Fig.* 1 are a tentative arrangement of this sort.

R.E.P.—M. Robert Esnault-Pelterie has a monoplane under construction at his works at Billancourt.

It has a fish body of steel tubing, canvas covered, with a screw tractor. The body is of very strong and light construction; one special feature is a neat arrangement by which one lever works in two planes at right angles to each other. This is a similar lever to the steering lever on the Wright machine, but is somewhat different in design.

The wings are so hinged at the points where they join the body that they can be "feathered," *i.e.*, twisted about the lateral horizontal axis. By this movement the lateral stability is controlled. They have at their extremities a small wheel, which keeps the framework of the wing from contact with the ground when starting or landing.

DE PISCHOF.—Another aeroplane seen was that of MM. De Pischof and Koechlin at their factory at Billancourt.

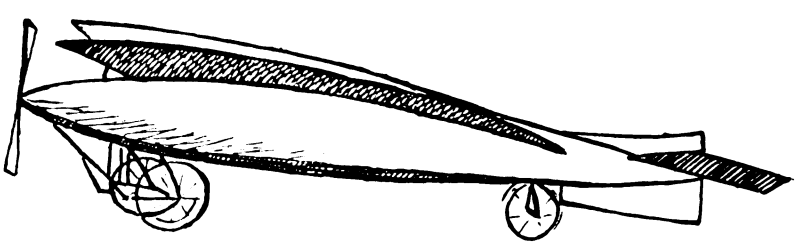


FIG. 3.—*De Pischof-Koechlin (side view).*

This machine is a monoplane and consists of a wooden fish-shaped body about 15′ long by 2′ wide by 18″ deep, mounted on a light

Digitized by Google

chassis of bicycle tubing with castor wheels. The horizontal and vertical rudders are at the stern, and the light triangular-shaped wings, about 9′ long by 8′ at the base, are mounted near the front of the body. The engine is of the Buchet type of 16-H.P., weighing about 45 lbs., and is directly connected to a screw tractor made of tulip wood, 4′ in diameter. The total weight of the machine is about 530 lbs. and its speed about 30 miles per hour.

The steering arrangements of this aeroplane are rather neat. For the horizontal rudder the inertia of the aeronaut's body is taken into account. As the machine swerves up or down, the aeronaut's body swings forwards or backwards, and thus pushes or pulls the steering wheel—causing the horizontal rudder to bring the machine back to the level.

The vertical rudder is actuated by turning the steering wheel.

If the machine tilts over sideways the aeronaut instinctively leans towards the other side, and—by a lever attached to his body—twists or "feathers" the wings in such a way as to bring the machine back to the horizontal plane.

ANTOINETTE.—The Antoinette aeroplane is a fish-bodied monoplane with a screw tractor. It has skate supports under the wings for use when landing. The pipes of the radiator are fixed along the outside of the body.

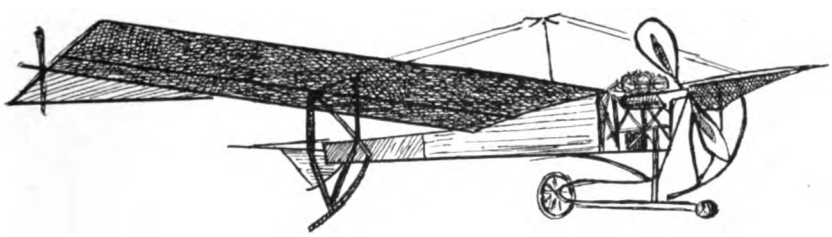


FIG. 4.—*Antoinette.*

WRIGHT.—The Wright aeroplane is of the biplane type, but differs considerably from the Voisin machines. It has no tail, and the main planes are so constructed and connected that they can be twisted so as to "feather" the outer edge, and increase the resistance of the inner or lower edge when rounding a corner, thus maintaining lateral stability.

The aerofoil consists of two planes 41′ long by 6′ 7″ wide, and about 5′ 11″ apart. The framework of these planes consists of two parallel beams 4′ 5″ apart, their ends being joined by the curved piece A (*Fig.* 6) which absorbs the shock if the end of the plane should touch the ground.

Digitized by Google

FIG. 5.—*Side View of Slats CC.*

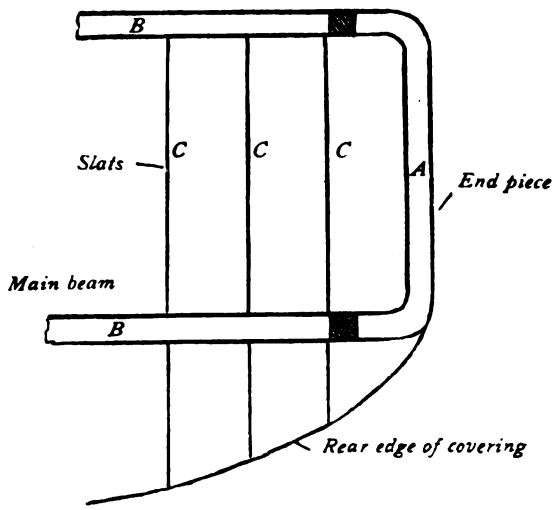



FIG. 6.—*Plan of Frame of Plane.*

There are 34 curved ribs or slats C (*Fig.* 5) on each plane; these support the covering material and give the plane the necessary curvature, which is about 1 in 20. The near end of these ribs is formed of two thin flexible slats, which are free to slide on one another, and thus alter the curvature of the back part of the plane when the air pressure causes them to do so (*cf.* feathers of a bird's wing).

The covering material is nailed to the front beams and also at the ends; at the rear, the upper and under coverings are sewn together. The material is put on diagonally, thus necessitating seams but avoiding wrinkles when the planes are twisted.

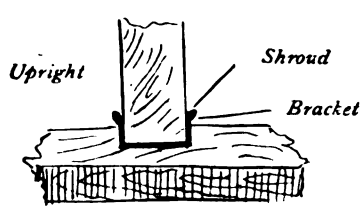



FIG. 7.

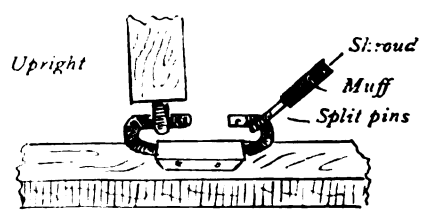



FIG. 8.

Digitized by Google

The two planes are connected by 18 uprights. The two uprights beside the centre one are fixed comparatively rigid, as shown in *Fig.* 7. The remainder are jointed, as shown in *Fig.* 8.

The wire shrouds have no straining screws; the ends are bent round to form an eye and passed back into a muff (*Fig.* 8) and soldered.

*Vertical Rudder.*—The vertical rudder is 8′ 10″ behind the main planes, and consists of two vertical planes A (*Fig.* 9) 5′ 11″ × 18½″ × 18½″ apart—slightly curved in outline.

They are rigidly connected and are attached to the main planes by the pieces EK, as shown in *Fig.* 9.

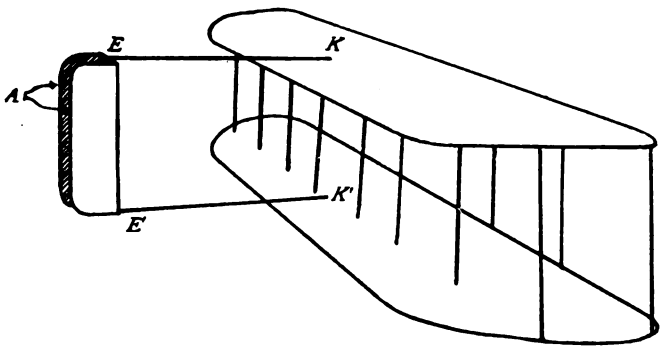



FIG. 9.—*Sketch of Wright Machine showing Vertical Rudder.*

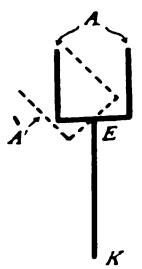



FIG. 10.—*Plan of Rudder.*

*Skates.*—The machine is supported on two skates of spruce about 1½″ × 2″ and 21′ 4″ long. Projecting 1′ 8″ behind the main planes, they are attached to the bottom plane by three struts about 1′ 8″ long (*Fig.* 11). It should be noted that these struts are not placed directly under the uprights of the body. About 13′ from the front edge of the aerofoil the skates curve upwards to form supports for the front or horizontal rudder. Although well braced, they have plenty

Digitized by Google

of spring, which is very noticeable when the machine touches the ground.

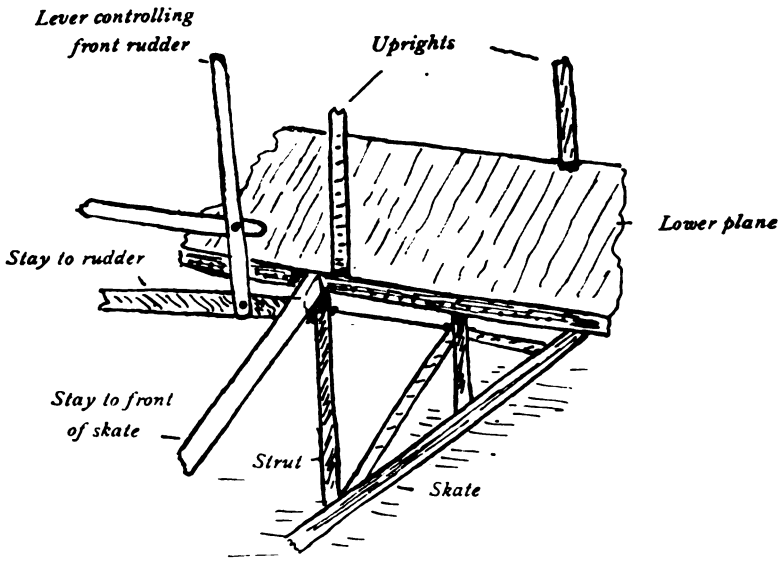



FIG. 11.

*Horizontal Rudder.*—This is composed of two horizontal planes 17′ 3″ × 2′ 7½″ × 2′ 11½″ apart, of the same curvature as the main planes, but this curvature is varied when the rudder is moved, as can be seen in *Fig.* 12.

Between the main planes are two fixed semicircular vertical planes.

The top plane of the horizontal rudder is about on a level with the prolongation of front edge of upper main plane.

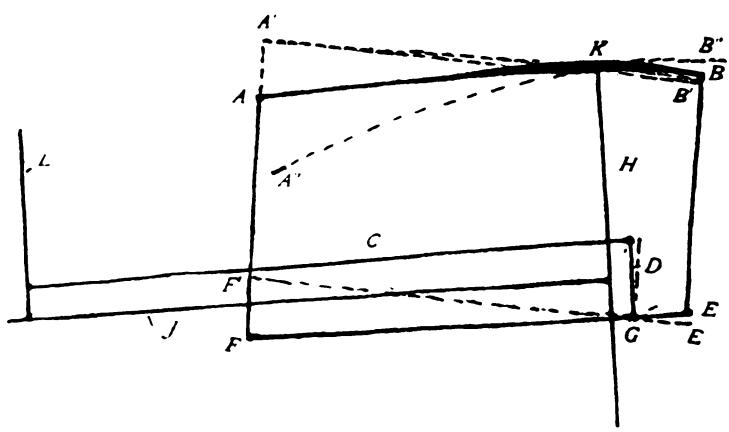



FIG. 12.—*Sketch showing Section of Half of Front Rudder.*

Digitized by Google

AB is top plane of horizontal rudder, H is one of the uprights which support the rudder, and which are in prolongation of the curved ends of the skates.

L is the lever which works the rudder and is pivoted on the stay J. On pushing L forward, the connecting rod C moves the short lever D forward. D is rigidly connected at G to EF, which is pivoted at G.

E therefore moves downwards and F upwards, but as EG, GF is not in the same proportion as BK, KA, the connecting rod FA moves further than the rod EB, and the curvature of AB is altered, becoming less when the rudder points downwards and greater when it points upwards.

*Motor.*—The motor is of a special design, of which few details are available.

It has four cylinders, each about $4\frac{1}{4}''$ diameter by $4''$ stroke.

Ignition is by magneto; there is no carburetor—petrol being supplied by direct injection.

There is a double exhaust, (*a*) exhaust valve, (*b*) at end of stroke. The engine is water-cooled by means of a circulating pump. The radiator is $5'$ $8''$ high and formed of four series of vertical pipes.

Weight of the motor is about 200 lbs.

H.P., 20/30. Revolutions, 1,200.

It is placed symmetrically with the aeronaut with respect to the longitudinal axis of the machine, and drives two propellers by means of two chains, one of which is crossed. The gear ratio is 33:10.

Both chains run in light steel tubes, and by crossing one the propellers are made to revolve in opposite directions, and thus the side reactions of the screws balance each other. The propellers are of

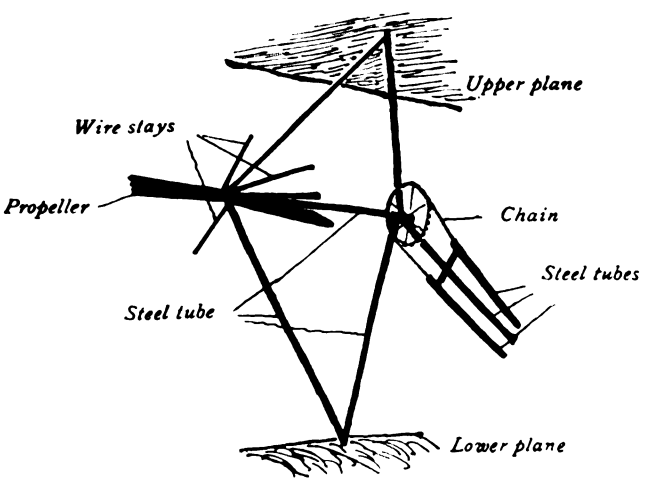



FIG. 13.

Digitized by Google

wood, and are 11′ 6″ apart, their axis being slightly above the middle of the distance between the two main planes.

Diameter, 8′ 6″; effective pitch, about 9′.

The propeller shafts are supported, as shown in *Fig.* 13.

The lever governing the vertical rudder and also the twisting of the planes has a four-way movement, *i.e.*, in two planes at right angles, so that the controlling of the "feathering" action may be done by the same lever, and at the same time that the vertical rudder is actuated.

*Twisting the Planes.*—The hinging of the uprights of the aerofoil admits of the twisting or feathering of the ends of the planes.

When it is desired to turn to the right the aeronaut pulls the controlling lever backwards and at the same time to the left, thus turning the veritical rudder to the right and at the same time lowering the right-hand end of the planes and raising the left. The resistance of the right or inner side is thereby increased and that of the left side decreased, thus raising the inner edge and overcoming the automatic banking effect due to the turning movement.

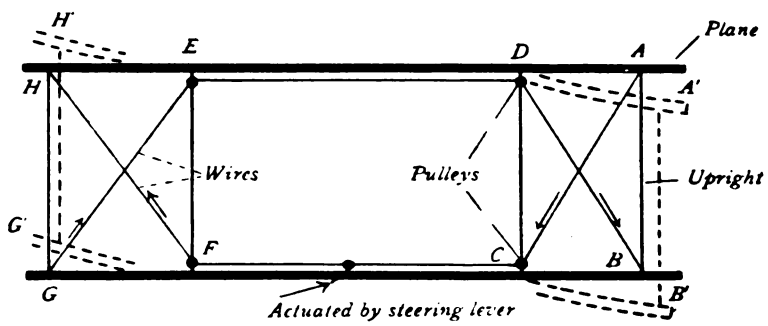



FIG. 14.—*Sketch to illustrate Action of Twisting Wings.*

The whole machine weighs, including the aeronaut, about 1,000 lbs., and the speed is about 40 miles per hour.

The area of the supporting surfaces is 500 square feet and the gliding angle about 7°.

The lateral and longitudinal stability are both dependent on the skill of the aeronaut.

ENGINES.—The following is a description of some of the principal engines made specially for aeronautical work, and it is the engine-makers whom we have chiefly to thank for the success which the heavier-than-air machines have lately attained.

*Gobron Brillié Engine* (*Fig.* 15).—This engine is made on the same principle as that used on the well-known car of the same name. It is of peculiar design, being in the form of a cross. There are eight

Digitized by Google

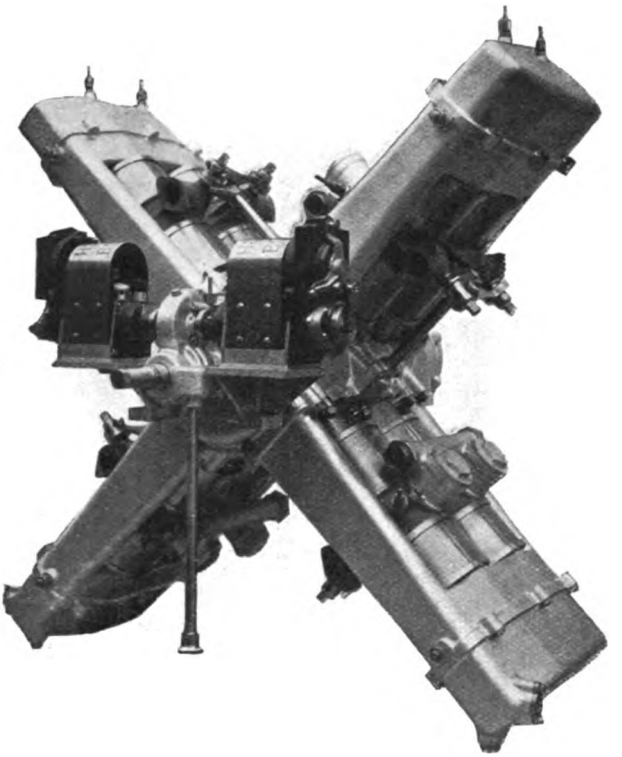


FIG. 15.—*Gobron Brillié.*

cylinders, two cylinders placed alongside being in each arm of the cross. The system of double pistons is adhered to, there being 16 pistons in all, *i.e.*, two in each cylinder, the cylinders being open at both ends. The pistons closest to the crank chamber are connected directly to the crank pins by connecting rods of the ordinary pattern, whilst the outer pistons are connected to swinging yokes, which are attached by longer connecting rods on either side of the cylinders to the crank pins. The explosion chamber is between the two pistons, the inlet and exhaust valves being situated half-way down the cylinder, as shown. The crank to which the inner piston is attached is longer than that of the outer one, in order to compensate for the additional weight of the moving parts of the outer piston.

The outer ends of the cylinders are cased in as well as the outer piston connecting rods, and all the lubricating oil can make its way from the top, through the cylinders, to the bottom of this casing, whence it is once again pumped to the top.

The lubrication maintained by this pump is said to be excellent. During a 14-hour run on the bench on full load, and using the

Digitized by Google

radiator supplied for use on an aeroplane, very little of the circulating water was lost from evaporation. This is especially good, since the radiator had not a continual flow of fresh air past it, as it would have in an aeroplane.

The water jackets consist of thin brass cylinders shrunk on, and this part of the construction is thus very much lighter than in motor-car work. The water is circulated by a pump driven off gearing on the main shaft; this gearing also drives the oil pump and magnetos, and is the only train of gear wheels on the whole motor.

The inlet valves are automatically operated by suction, and are on opposite sides of the cylinders to the exhaust valves. The exhaust valves are worked in pairs by a double-armed lever pivoted between them and actuated by a shaft, which projects into the crank chamber and is revolved backwards and forwards by two eccentrics on the main axle. The weight of valve gear is thus reduced greatly, and it is exceedingly simple and accessible. Ignition is by the two magnetos referred to above, and the sparking plugs can be seen close beside the inlet valve. There are double sets of rings on the pistons, which are said to give very good results. The accessibility of the engine is very good, the casing caps, which are fastened down by six nuts, having only to be removed to get at the pistons. The material used is of the best and the workmanship is excellent throughout.

Dimensions:—Cylinder diameter, 3·5″. Combined stroke of pistons in one cylinder, 7″. Weight of engine, piping, and carburetor (radiator full, 26 pints) is 330 lbs. B.H.P.=80 at normal speed, but at 2,000 revolutions per minute=120. Cost £500.

*R.E.P. Engine* (*Fig.* 16).—This engine is made at the works belonging to, and set up specially for that purpose by, Monsieur Esnault-Pelterie, at Billancourt. The engine is of first-class workmanship, and is made in varying sizes, as many as 10 cylinders being connected on one shaft with but four crank pins. The cylinders attached to a crank pin are all in one plane at angles of about 25° apart. With a 10-cylinder engine the arrangement of the cylinders on the four cranks is as follows:—Two pistons on each of the end crank pins and three on each of the centre pins. The method of connecting the connecting rods to the crank pin is by having a loose ring on the crank pin, having as many lugs bored to take gudgeon pins for connecting to big end as there are cylinders working on the crank. The inlet and exhaust valves are combined in a very neat type of piston valve worked by push rods and rocking levers.

A 35-H.P. model, everything included, weighs 140 lbs. It is air-cooled, and in the monoplane constructed by Monsieur Esnault-Pelterie was placed in front driving a tractor screw. Cost of this model is £400.

Digitized by Google

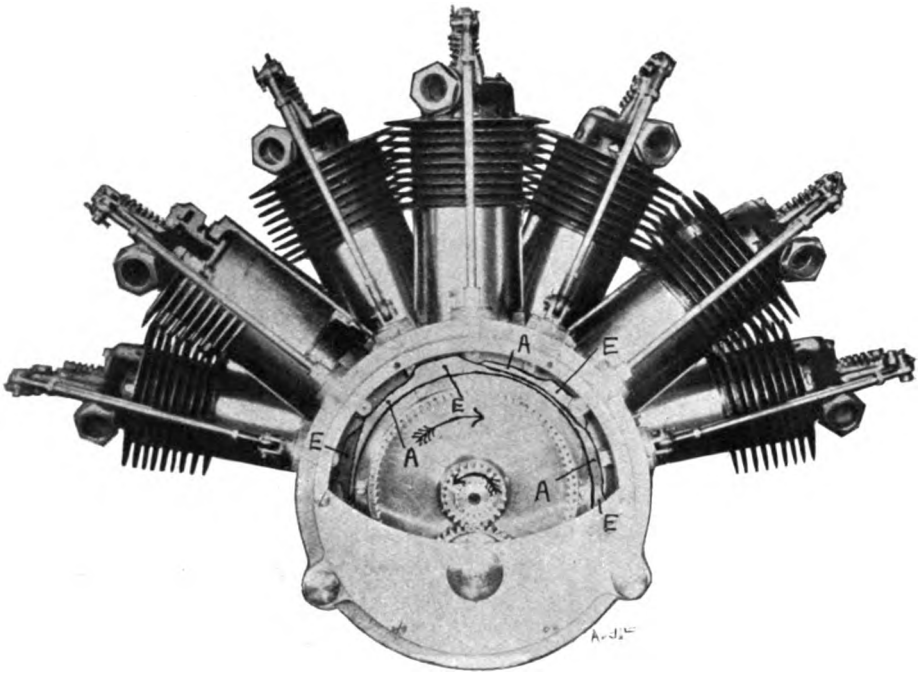



FIG. 16.—*R.E.P.*

*Gnome Engine.*—This is an engine of unusual design. It is air-cooled, and to this end the seven cylinders are mounted round an aluminium crank chamber at equal angles. The crank is fixed, the cylinders and crank chamber revolving about it, and the propeller being fastened to the crank chamber.

The combined inlet and exhaust valves are mounted on the cylinder heads, while a couple of high-tension ignition plugs are also mounted in each head on the opposite side to the combined valve. The valves are actuated by push rods connecting the rocking lever on the cylinder heads to the 2-to-1 gear mounted on the two spindles visible on the face of the crank chamber. The ignition is by magneto or by accumulator, the connections and distribution being somewhat complex owing to the system of revolving cylinders being adopted. Lubrication—which was said to be a cause of difficulty at first, as all the oil found its way into the cylinder heads by centrifugal action—is said to be good, the difficulty referred to having been got over.

One feature of the engine is that it is mounted wherever possible on ball bearings, and another is the hollow crank shaft through which the mixture is supplied from the carburetor to the cylinders. The workmanship of the engine, so far as was possible to find out, was good, an engine not being seen dismantled.

Digitized by Google

The engine is quite accessible, but seems unnecessarily complicated, and, owing to the main body of the engine with valve gear revolving, rather liable to get out of order.

Weight of engine (seven cylinders), complete with magneto accumulator, tank, carburetor, etc., was 143 lbs., and B.H.P. was 50. Cost £400.

*Buchet Engine* (*Fig.* 17).—Somewhat like the R.E.P. engine is the Buchet, which also is made in varying sizes. A 16-H.P. model is used by Monsieur De Pischof in the De Pischof-Koechlin monoplane, giving satisfaction.

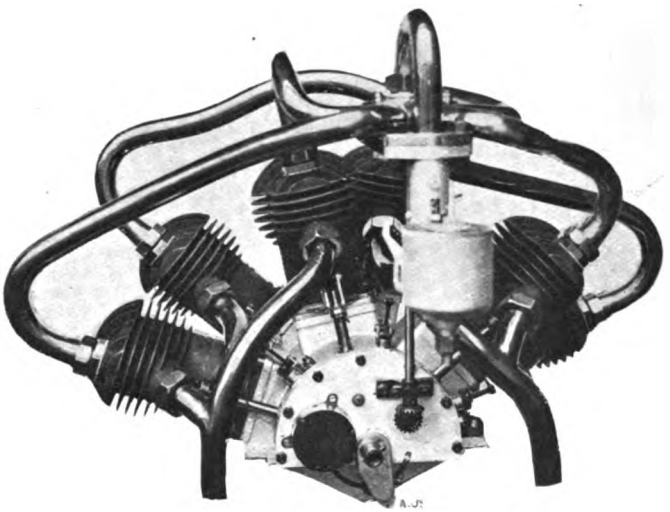


FIG. 17.—*Buchet.*

The 24-H.P. model with six cylinders, arranged at angles of 22½° to one another, has two crank pins with three cylinders on each. Each cylinder has its supply of combustible mixture regulated by a distributor, which is driven by bevel gearing. This distributor is placed at the junction of the six induction pipes, its function being to allow a cylinder to get its proper share of mixture, notwithstanding a longer length of induction pipe. It is an air-cooled engine, being otherwise fairly normal in design. The inlet valve is actuated by suction, the exhaust mechanically by three cam shafts actuating the six necessary push rods.

Weight of 24-H.P. model is 110 lbs.

*Clement-Bayard.*—This is another multi-cylindrical engine with its cylinders arranged equi-angularly round a crank chamber. It is designed to work with the main crank shaft vertical.

It has seven cylinders and, like several other aerial engines, the valves are worked by a single push rod and rocking lever per cylinder. The seven push rods are actuated by a cam, concentric

Digitized by Google

with the crank shaft, driven at half-speed by a lay shaft, which also carries the distributor. Beneath the crank chamber is a circular chamber, in which is a centrifugal pump direct driven from the crank shaft, and an annular mixing chamber round the shaft, to which the induction pipes are brought and which is connected also to the carburetor.

*Other Types.*—There are several other types designed specially for aerial work.

Of these, one is the Farcot engine (*Fig.* 18), with eight cylinders set radially in two planes round a crank chamber and two-throw crank. The inlet and exhaust are very cleverly combined in one. A special feature is the fan driven by the main shaft for cooling the engine; and also the driving shaft at right angles to the main shaft, considerably geared down to enable the engine and also the propeller being run at economical speeds. B.H.P., 50; weight, 121 lbs. At 1,200 revolutions 69 H.P. has been obtained. Lubrication is by force pump through hollow steel crank shaft.

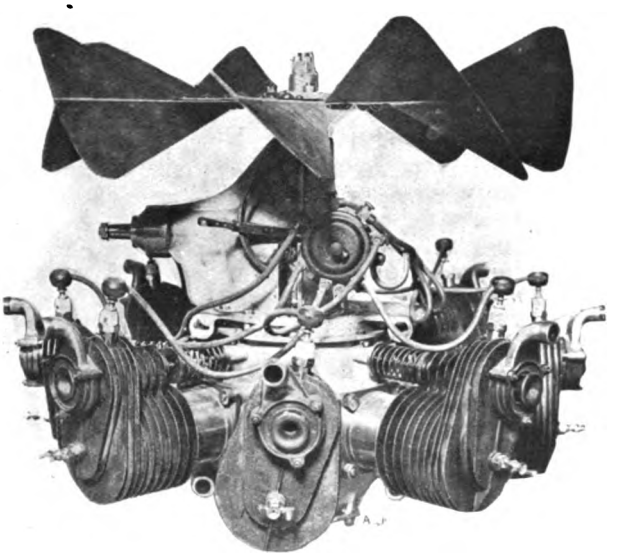


FIG. 18.—*Farcot.*

There are several engines made on the V principle, the 8-cylinder E.N.V., 8-cylinder Pipe, and 8-cylinder Antoinette being the most notable.

Digitized by Google

*Details of Types Described.*

| Engine. | Weight, everything included. | B.H.P. | Cost. | Remarks. |
|---|---|---|---|---|
| Gobron Brillée (*Fig.* 15) | 330 lbs. | 80 | £500 | 120 at 2,000 r.p.m. |
| Gnome ... ... ... | 143 ,, | 50 | £400 | 1,200 revolutions. |
| R.E.P. (*Fig.* 16) ... ... | 140 ,, | 35 | £400 | 1,600 ,, |
| Buchet (*Fig.* 17) ... ... | 110 ,, | 24 | — | 1,800 ,, |
| Clement-Bayard ... ... | 150 ,, | 50 | — | 1,200 ,, |
| Farcot (*Fig.* 18) .. ... | 121 ,, | 50 | — | 69 at 1,200 revs. |
| E.N.V. ... ... ... | 310 ,, | 50 | — | 1,000 revolutions. |
| Antoinette ... ... | 220 ,, | 55 | — | 1,600 ,, |
| Pipe ... ... ... | 288 ,, | 70 | — | 1,800 ,, |

The authors desire to acknowledge their indebtedness to the following gentlemen :—

Messrs. Voisin, Gobron, Esnault-Pelterie, De Pischof, and Lanchester; and also to the periodicals, *La Revue Aerienne* and *Automotor Journal.*

The Photo-blocks of Engines were kindly lent by the proprietors of the *Automotor Journal (Yellow Cover) and Flight.*

Digitized by Google

# *NOTES ON THE EMPLOYMENT OF SAPPERS ON THE WORKS.*

*By* A Company Officer.

In considering the question of the employment of R.E. labour on the works it will be of interest, as well as of some assistance to us, to take note of the needs which originated the policy of enlisting tradesmen into the Army. Before the year 1772 the works at Gibraltar were carried out by civilian workmen from England, who were under no agreement and could leave whenever they pleased. Consequently the works suffered considerably, and it was decided to raise a body of workmen who should be amenable as soldiers to military discipline, and whose services could always be counted upon. The Soldier Artificers, as they were called, were exclusively employed on the works, and in the first instance were not armed at all, though the different companies gradually acquired weapons of varied natures which had been discarded by the troops, or were otherwise obtainable. Only their uniform distinguished them from their civilian fellow-workmen, as well as the fact that they could be punished by means other than fines or dismissal. Little or no attention was paid to military efficiency, and at the end of the 18th century we read that drunkenness was very prevalent and discipline seriously relaxed. The appointment of Engineer officers to companies was merely nominal, and being constantly shifted from one unit to another, they were disinclined to take any great interest in the men. Altogether the state of the Corps was unsatisfactory.

It was evident that these evils could only be checked by a more rigorous attention to drill and military exercises, though at the same time an improved class of man was recruited. At this period therefore the military element began to make itself felt in the Corps, and since then our military duties have continued to take up more and more time, until at the present day they threaten, in some units, almost entirely to prevent the employment of sappers on the works.

But while his training as a soldier is of vital importance, the fact remains that the sapper's trade is the only feature which distinguishes him from the bulk of the Army, and it is to his skill as an artificer that we must always look to maintain a reputation for efficiency in the Corps. On the other hand, in wars and sieges our duties as field engineers have become so varied and arduous that it is only by devoting a considerable proportion of the sapper's time in peace to

Digitized by Google

this branch that we can hope to attain the requisite efficiency, and this must of necessity reduce the number of days during the year on which his services will be available for the purposes of the division officer. Indeed, in these days of scientific soldiering our standard has become so high that, in field units at any rate, preparation for war must come first, and any saving which may accrue through the employment of sappers on the works must be looked upon as a by-product of the process of turning out good field engineers. So that now the artificer of 1772 has become a soldier who has, in addition to his military accomplishments, certain trade qualifications which are of high value to an army in a theatre of war, and which must be fostered and improved as much as possible during peace.

It therefore becomes necessary in some way to divide up the sapper's time between employment at his trade and training for war, and it is suggested that the most satisfactory solution of this would be that he should, roughly, work during the winter and train during the summer. If this were done the winter would be entirely devoted to work, in the sense that between the 15th September and the 15th March no man would be taken either for inspections, reviews, winter training, or any other form of military duty for a single day. It cannot of course be contended that 6 months during a year, of which a proportion is probably spent on furlough, are sufficient to maintain such standard of skill at trades as would be necessary in civil life. The arrangement would at best be a compromise, but it could hardly fail to be an improvement on the present system, which often necessitates men leaving their jobs half finished to go on drill, signalling, etc.

It is also important, as far as possible, to employ the sapper on such work and under such conditions as will most fit him for the duties that will be expected of him in war. No matter how good the supervision may be, the ordinary routine of incidental work is almost sure to give him opportunities for "slacking," and very often a considerable proportion of his time may be occupied in journeys from his place of work to the R.E. yard and back. Odd jobs about barracks do not interest him, and do little to improve his skill at his trade. They also tend somewhat to relax discipline, and on this account alone are undesirable.

The conditions most favourable to the maintenance of efficiency in any R.E. unit (exclusive of the "specialist" units such as telegraphs, search lights, etc.) appear to be :—

(1). That the officers of the unit shall be the designers of all work undertaken by their men.

(2). That the N.C.O.'s shall directly supervise the work.

(3). That the sappers shall work in parties under supervision, each section of a company, as far as trades allow, being employed on some definite service.

Digitized by Google

Under such a system the officers would have a more direct interest in the work of their companies than is at present the case, while the men would feel that they were really working for their company officers, as distinct from the division officer, whom they perhaps do not know, and that good work will bring them material advantages in the way of promotion and indulgences.

To fulfil the above conditions it will be seen that only new work or work under Part II. (Minor Alterations) will be suitable. Division officers at stations where there are R.E. units may argue that their allotment for minor maintenance will not admit of repairs being carried out entirely by the contractor. In answer to this it may be urged that it is for the benefit of the Army to make such increases in those allotments as may be necessary for our purpose, and, further, that the employment of sapper labour on any work merely conceals, without very greatly reducing, the actual cost to the public of that work. The savings on those items undertaken by the sappers should also be treated as a set-off against the additional expense caused by the carrying out of repairs by the contractor.

If the system outlined above were followed, the division officer, as soon as the allotments were received from the War Office, would have to consider what services could, through not being of the first urgency, be conveniently postponed till the autumn. Of these, he would, in conjunction with the captain of the company (they will often be one and the same person), select such as could in the opinion of the latter be conveniently carried out by his company. The captain would thenceforward entirely take the place of a contractor as far as those particular services were concerned.

Now there are several points which here call for careful consideration. Firstly, the services selected would have to be within the powers of the unit to perform in the time available, due allowance being made for bad or frosty weather, which will cause delays. It is not an easy matter to estimate the amount of labour which a company will provide during a winter. The numbers will fluctuate more especially at this season, owing to drafts, furloughs, etc. There are three classes of units to be considered, namely, (1) field troops, (2) field companies, and (3) fortress companies, practically all the other units having their special technical duties, to which the whole of their time must be devoted.

(1). In a field troop the care and exercise of the horses during the winter absorbs most of the men's time. It will not as a rule be possible to count on much labour as being obtainable from these units, except from the drivers with their pairs, nor does the present organization seem to give a reasonable chance of skill at trades being maintained. If it were thought desirable to remedy this state of affairs it would appear necessary for the establishment of sappers in a field troop to be increased, and by the introduction of a longer

Digitized by Google

period with the colours the proportion of men under instruction in riding could be reduced.

(2). The field company establishment of 100 sappers would appear at first sight to give a large party of men for the works, but on closer inspection we find that immense deductions have to be made to arrive at the actual number we shall find on the daily working parade during the winter months. To begin with, at the present time all units are kept permanently at 33 per cent. below establishment, leaving 66. Next, in order to allow every man his six weeks' furlough during the 26 working weeks, another 25 per cent. (say 16 men) must be deducted, leaving 50. Then there will be the tailor, shoemaker, saddler, wheeler, storeman, cook, four cook s-mates, etc., say 12 men in company employ; also probably three printers, one or two engine drivers, and one or two required as clerks in the C.R.E.'s or D.O.'s Office. The R.E. Workshops possibly absorb five or six more. Hence, out of our imposing establishment of 100, we are left with a working party of no more than 25 sappers.

(3). Fortress companies, whose establishment of sappers averages about 40, can seldom turn out a working party even 10 strong during the winter, for while they have less than half the strength of a field company, the numbers absorbed by "company employ," etc., do not decrease in proportion. With so small a party, in which there is a fluctuating proportion of trades, it will hardly be practicable to undertake constructional work with any hope of completing a job in a given time; it is therefore not intended to include fortress companies in the scheme herein proposed. They can be usefully employed on incidentals, advantage being of course taken of any small new works which may present themselves.

Taking, then, our field company average daily working party of 25, we now wish to arrive at a rough estimate of the extent of work to be expected of them during the winter. It may help us to adopt the following method:—Take from the local schedule the average rate per diem paid for civil labour in the various trades. This in the Chatham sub-district works out at 4s. 8d. for an 8-hour day for the 15 commonest trades, with 25 per cent. of labourers. Then, as the number of working days during our 26 weeks is about 125 (allowing Saturdays for fatigues, etc.), the value of the labour obtainable from the company should be £730. We must however deduct, say, 10 per cent. from this on the grounds that a proportion of our tradesmen will not be up to the standard of skill contemplated by the schedule, giving us a figure of £657. Taking the ratio of labour to material as 45:55, as is the case in erecting an ordinary brick building, we arrive at the conclusion that the company ought to complete a service, or services, shown in the annual estimates at £1,460.

Although at first sight this appears to be a low figure, it is doubtful whether any company commander would wish to dispute it, or

Digitized by Google

expect more from his company. With things as they are, the only way to increase it would be to reduce the number of men taken away from the works. Companies are at present maintained below their peace establishment for administrative reasons which are doubtless unavoidable. But it is open to objection that the printers, photographers, draughtsmen, lithographers, etc., should be posted to service units when they are to be used for station requirements only. They belong more properly to the Supernumerary Staff, and their places in the company could be filled by artificers, who would really form part of it. The inclusion of three clerks in the establishment might possibly be altered, and one only considered sufficient. They are often used for station purposes, and it is sometimes even necessary to take skilled tradesmen for clerical work in the C.R.E.'s or D.O.'s Office, which is surely very undesirable. If a proper staff of clerks could be provided for the R.E. offices it would be unnecessary to call on the companies for assistance of this nature.

The duties of the officers now call for consideration. The captain, having selected the services for execution, would arrange for one of his officers to prepare line drawings fully dimensioned and fitted to sites. So far the only drawing available will be the rough sketch attached to the correspondence in which the service was proposed, or there may be no sketch at all. The officer will have to go into the matter thoroughly and make drawings fit to work from. He would have to find time for this during the training season. These line plans would then be submitted in their rough state for the C.R.E.'s approval, and if approved would be drawn out in the draughtsman's office—these drawings being preserved, to be produced when the company is inspected. During the progress of the work the officers would be on the spot as much as possible. There is no doubt that all field company officers would, under these conditions, take a very real interest in the works, and would gain experience such as cannot now always be obtained.

As regards the N.C.O.'s, there would probably be more sergeants and corporals present than would be actually necessary for purposes of supervision. Those who show most aptitude for the duty should be selected, and these would be in the position of minor foremen of works. They would take over the stores purchased for their particular service, arrange with the section sergeant for the transport they require, get their workshop jobs in hand, keep a diary, and supervise all the details of their work. This is a system which at certain stations has been followed with conspicuous success, and might well be generally adopted. Their confidential reports should show, in the column provided for "Special Qualifications," whether they had been notably successful or the reverse.

Those corporals for whom there may be no independent works to supervise might with advantage be handed over to the D.O. for

Digitized by Google

employment, *e.g.*, as acting foremen of works at out-stations, superintendents of R.E. civil labourers working on roads, etc., or if there is no such work for them, they must of course work at their trades, and at their own wish should always be allowed to do so.

The selection of services suitable for execution under this scheme would be a matter of some difficulty, owing to fluctuations in the proportions of the different trades. A single complete building of suitable dimensions would be the best, if such is to be built, and furloughs could be fairly well arranged to suit. But it is unlikely that a company would often be lucky enough to get such a job, and the object in view in selecting work would be to provide each man with a suitable task for his winter's work. If several smaller services were taken, the selection should include a building job, a water or gas-piping job, a sanitary or plumbing job, and if possible a wood or corrugated-iron hut, which would give the carpenters practice in a very important branch of their duties in a theatre of war. The aggregate estimated cost of these services should be as above computed.

In order to increase the output of work from the artificers, every possible use ought to be made of infantrymen as labourers. At present a couple of sapper bricklayers are often employed on a job which could be equally well done by one bricklayer with a labourer. Infantry brigadiers and C.O.'s have hitherto been generally averse to allowing their men to work for the R.E., but now that every soldier must learn a trade the above would appear to be a useful and instructive form of employment.

The knowledge they would acquire of concrete, mortar, paint, scaffolding, etc., would also probably be far more useful to them in civil life than the telegraphy and carpentering which they are now endeavouring to learn, but in which they are unlikely ever to reach a high enough standard for civil employment.

It is hardly necessary to say that the same men would need to attend daily and work at the same trade continuously, and as far as possible with the same sapper. They should receive the labourer's rate of 4d. per diem, which might be charged against the item.

In addition the ordinary infantry working parties could be used for excavation, moving heavy stores, etc., whenever available.

The question of piecework is one that may here be mentioned. At present the regulations do not contemplate the employment of sappers in this manner. To do so would, in the first place, put a premium on hasty and careless work. Then it may be argued that as the sapper is given only a very small remuneration for his day's work as compared with his civilian fellow-workman, it is not fair to expect more than an average day's work from him; and, further, that if he idles on the work it is open to the C.R.E. to reduce his rate of Engineer pay. Or, again, the soldier, being sure of his daily bread,

Digitized by Google

would not, if naturally an idle man, be induced to work any harder for the extra pay obtainable, while the measuring up of tasks and the keeping of the necessary records would involve a considerable amount of work for the superintending staff.

Conversely, it may be advanced that an industrious and hardworking man ought, if he wishes, to be able to earn more than his more idle comrade; that the N.C.O. in charge of each job could without any difficulty keep all necessary records; and that any tendency to put in bad work could be checked by taking the offender off piecework.

On the whole, the arguments against the system seem to be strong enough to at any rate make its general introduction undesirable. But there would seem to be no reason why a good tradesman should not, if he elects to do so, be allowed to take piecework with a view to earning some addition to his Corps pay. It would first of all be necessary to determine what rates should be paid for various jobs, so as to give the desired result. The pieceworker would of course continue to receive the Corps pay paid to him under Royal Warrant. We should want to give him a proportionate increase for any work he might have done over and above what we should ordinarily look for from a sapper in a day's work, and we should want this increment to be substantial enough to induce men to take piecework, provided that the public were not the losers.

A system was introduced in South Africa, and worked with some success, by which the men were enabled to earn up to 2s. per day on piecework. A special schedule, comprising some of the commoner jobs on which they were employed, was prepared, its prices being arranged so that a good day's work ought to bring the man in about 2s., the difference between the amount earned and his Corps pay being found from the item. It is suggested that some such scheme might be made general. The preparation of this special schedule would need a great amount of attention, and it would probably take the experience of a few years' working to adjust the rates exactly. But the number of items contained in it need not be large, as it would only provide for work of a simple nature being done by piecework. It would seem however more logical to put no limit on the amount that the sapper could earn in a day, for such a limit appears to defeat the object of a piecework system, which is to get as much work done as possible. And to make the system workable there should be no multiplication of checks and vouchers. The measurements should be made by the N.C.O. in charge of the job, and checked by an officer, whose signature should be sufficient authority for payment. Extra earnings should be paid over to the sappers weekly in cash by the division officer, and not credited in their accounts, so that they could more easily realize that they are being paid for their extra efforts on piecework.

Digitized by Google

In order to encourage the N.C.O.'s to get as much work as possible out of their parties, it is strongly recommended that they should be given some pecuniary interest in the results of their work. They might be rewarded in proportion as the actual ascertained cost of the work falls short of the original estimate, though space does not here admit of the elaboration of such a scheme.

The above notes have been written chiefly from the point of view of a field company, both for the reason that the writer's experience has been with these units and that it is the field companies which appear to be most in need of some settled scheme which will reconcile their military duties with that trade standard which it is so important that they should maintain.

Finally, it is not claimed that any of the arguments used or the suggestions made are original. Each point has doubtless been already considered and successfully dealt with at some station or other. But it is felt that, if only the experience gained could be collected and issued for general information, it would go a long way to settling the many questions on this subject, which modern conditions nowadays often render very pressing.

Digitized by Google

# *SOME POSSIBILITIES OF MODERN FORMS OF TRANSPORT.*

*By* CAPT. R. WALKER, R.E.

WHEN studying the various problems connected with transport in the Service, the first point to consider is for what uses it will most probably be required. The principal of these are :—(1), For weapons, such as rifles, machine and field guns, etc.; (2), for ammunition; (3), for men and possibly horses; (4), for the carriage of technical equipment, food, and kits; (5), for the carriage of veterinary equipment and hospital stores, etc.

In order to meet these requirements, the following are the various forms of transport at present in use :—

(*a*). Man carriage—either on the person or by wheelbarrows, etc.
(*b*). Animal—pack-horse, mule, ox, camel, elephant, etc.
(*c*). By cart or wagon.
(*d*). Water transport, by barge, steamer, etc.
(*e*). By rail, tramway, etc.
(*f*). By cycle—either ordinary, folding, or motor.
(*g*). Mechanical transport, such as motor car, motor bus, delivery van, lorry, tractor, etc.

And possibly in the near future

(*h*). Aerial transport, by dirigible balloon, aeroplane, etc.

Detailed comparisons of various forms of transport are given in Table I., but (*a*) to (*d*) fall outside the scope of the following notes, and it is proposed only to consider the others in so far as they have a special military bearing.

The first form of transport to be considered therefore is that of railways. In war both existing rail and tramways may be used in whatever form they occur, but in the case of electric railways a great drawback exists in that the power plant will generally be well behind the frontier, and the use of the railway will for this reason be easily denied to an enemy. It may therefore be better for him to destroy an electric railway, as its destruction is a particularly simple matter, whereas the repair is by no means so simple.

If railways are required and do not exist, it is usual to extend

Digitized by Google

existing ones with the same gauge as far as possible. Where this cannot be done, tram lines with horse or mechanical haulage must be extemporized.

Owing to the introduction of the motor there is a constant diminution in the numbers of suitable horses, and we may anticipate ere long the substitution for them of steam, petrol, or electric tramways in localities where the roads will not admit of motor road transport. In some cases, such as sieges, etc., an electric system will be desirable, if not imperative, owing to the noise and smoke of steam or petrol engines, and if ever the monorail comes up to expectation, it will, without doubt, be the easiest tramway to construct.

The next form of transport to consider is the cycle, and it is obvious that its greatest use is in transporting men rapidly from point to point as M.I. Ordinary and folding bicycles are already used for this purpose, and the principle might easily be extended to motor cycles. If this were done the men might be armed with heavier rifles—such as the Hotchkiss Q.F. rifle—as they would never be called upon to carry them far. If a force so armed were supplemented by one or two motor cars carrying machine guns and extra ammunition, it would probably prove most useful.

In addition to the above, cycles might be used for reconnaissance or the transmission of orders and information, whilst staff officers would find tricars or trailers extremely useful on occasion.

The drawbacks to the use of cycles are :—

(1). Liability to puncture.
(2). Inability to travel fast across country.
(3). Length of road occupied by a body of men (*cf.* Table II.).

In addition motor cycles are :—

(4). Heavy to push across country or up steep hills, and
(5). Noisy.

Excepting (5) the above are obvious drawbacks, but it is conceivable that a judicious use of silencer and exhaust direct into the air would enable one to deceive an enemy as to one's distance.

The tactical use of cyclist infantry is practically the same as that of M.I., their greater mobility making it possible to cover greater distances in a given time. A reserve entirely mounted on motor cycles would be a most useful asset. The most useful organization would seem to be by battalions for M.I., and special cyclists allotted to staffs, cavalry and infantry units.

*Foreign Practice.—Austria* has a motor cycle volunteer corps ; all motor cycles are registered, and reservists who own them will

Digitized by Google

generally be called upon to use them in war time. They have been tried for laying telephone wires, and as M.I. attached to cavalry.

*Denmark* has a motor cyclist battalion armed with Q.F. rifles.

*France* has motor cycles allotted to staffs, and folding cycle companies.

*Germany* has motor cycles allotted to staffs.

*Italy* has a cycle volunteer corps, and motor cycles allotted to cavalry and infantry units. She also has folding cycle battalions.

Mechanical road transport, which has next to be considered, embraces not only the forms in daily use, but also many special forms which have been evolved to meet the peculiar requirements of active service. It is doubtful however whether it would be expedient to use the latter, as they have to be specially manufactured and are soon out of date, whereas the usual patterns are always to be had in large quantities and thoroughly up to date.

The question of driving power is a very important one in mechanical road transport, and all experiments so far have taken the line of distributing it as much as possible.

*Four-Wheel Drive.*—The commonest way of doing this is to arrange that all four wheels of the motor vehicle are drivers, the power being transmitted to the wheels from one or two engines and differential gears, or from four engines direct. A particular form of the latter is one in which the wheels are each driven by an electro-motor, taking power from a dynamo driven by a petrol engine, the dynamo sometimes being specially designed to give constant watts at constant speed (Mercédes Mixte); such a combination may have an efficiency of 75 per cent., whereas 50 per cent. is as much as can be obtained by mechanical transmissions; on the other hand, the *personnel* require an electrical as well as mechanical knowledge, which militates against their being introduced for civil work.

The advantages of a four-wheel drive are twofold; firstly, there is less chance of sticking owing to the wheels not gripping sufficiently in bad places on the road, and secondly, the whole weight of the vehicle is utilized to grip on the road, and the tractive power of a vehicle nearly doubled. Roughly speaking, with one pair of wheels driving a vehicle will pull its own weight, and if this weight is small it can only pull a small load; by increasing the number of driving wheels the weights of vehicles may be kept small, and this is done in certain special road trains, where a pair of wheels on every truck is driving, such wheels may be driven mechanically (Renard) or electrically (Siemens, Porsche), the latter being the more efficient.

Another attempt to solve this problem is the peculiar drive known as the "Caterpillar," in which a pair of endless chains, long lengths of

Digitized by Google

which rest on the ground, take the place of wheels. The links of these chains have square blocks on them which act as feet; the facility with which they can go across country promises well for their future; in turning sharp corners however they rather cut up the roads.

Armoured cars with and without guns have been designed, but they seem to have no *raison d'être;* it were better to trust to speed to avoid being hit than to run the risk of being knocked over by a shell. It might however be worth while armouring gear boxes, crank pits, and providing a duplicate radiator.

Cars have been fitted with special guns for firing vertically at dirigible balloons, which would be chased by the cars.

The uses to which automobiles can be put is apparently limitless; the following are the most important :—

(1). To move staff officers and orderlies about rapidly, and to carry out reconnaissances.

(2). To assist cavalry reconnaissances and in the transmission of information, for which they might some of them be fitted with a wireless telegraph equipment.

To bring machine guns and ammunition near the point where they are required. To collect supplies for the strategic cavalry which may entail covering large distances.

(3). With artillery they may be used to move the staff rapidly from position to position. To save the teams by towing guns when on the roads; this would appear to be worth considering for R.H.A., as it would enable them to cover great distances without fear of tiring the teams before coming to cross-country work.

To tow or carry all ammunition which is not actually required in the position, thereby economizing horses, reducing the length of a column and allowing the ammunition to be placed further behind, as it can rapidly be brought up when required (*cf.* Table III.)

(4). Engineers might find them useful for carrying technical equipment more rapidly than is now possible, and thus allow it to be normally further to the rear.

Officers could prepare for work by getting to the sites in the minimum time. The engines of the cars could be utilized for driving such machines as search-light dynamos, pumps, circular saws, and other tools, which are necessary for the repair of guns and motors.

Possibly they might be of assistance in laying telegraph wires.

(5). Infantry could use them—in the same way as motor cycles—for the rapid transport of men. The ordinary car, even if provided with special bodies to carry say eight men, would take up more road space than infantry marching, but the motor bus would not; in both cases the speed is much greater (*cf.* Table II.).

Digitized by Google

The men so carried could be armed with Q.F. rifles, and machine guns with tripod mountings could be carried, as well as a large supply of ammunition.

Table IV. shows the potentiality of this form of transport, making use of the motor vehicles in London.

(6). For transport and supply the heavier motor vehicles are required. By using them for columns and parks it would be possible to reduce their length, and hence their vulnerability, and it would also be possible to leave them further to the rear than would otherwise be the case.

Table V. shows the advantages worked out for the 2nd line transport of a division.

*Special Difficulties.*—The military automobilist encounters special difficulties under prolonged Service conditions, by no means the least of which are bad weather and road conditions, which necessitate the use of high-powered vehicles and very careful driving and attention.

*Bridges.*—The necessity for all vehicles, which will use them, being sufficiently light not to damage military bridges is another point to be carefully considered. The usual military bridge will take ordinary field loads, but is not strong enough for lorries, traction engines, or motor buses, nor, for the matter of that, for heavy artillery (60-pr.). It would seem advisable therefore either that bridges should normally be strong enough to take the 60-pr.—in which case they would take the average lorry—or that they should be built in such a way that they could easily be strengthened to take lorries, all main road bridges being normally so strengthened. Table VI. shows some of the loads brought on bridges.

For reconnaissance purposes motor cars may have to cross minor obstacles, and should be supplied with a light equipment to take them over gaps up to about 20′ in width.

In our service we may be called upon to fight in any portion of the globe, and at very considerable altitudes. The effect of altitude on steam engines is negligible, but not so in the case of explosive engines; an ordinary petrol engine taken up to 5,000′ will only give out about one-half its power, owing to the rarity of the air and loss of compression; and the greater the altitude, the less the power will be. By specially altering an engine its power may be increased up to 75 per cent. for an altitude of 5,000′, 50 per cent. up to 8,000′, etc.; but when so altered the engine is not suitable for a much lower altitude. It would be impossible to be constantly altering your engine for each change of altitude, and for a theatre of war varying from 0 to 5,000′ therefore it would be necessary to have an engine twice as large as would, at first sight, appear to be required. Steam-engine plants can be made which weigh barely twice that of a petrol

Digitized by Google

plant of the same power, so that for altitudes of 5,000′ the weights of engines would be about the same, and for heights above 5,000′ the steam plant would be the lighter. Should the two-cycle petrol engine become a commercial article, the petrol engine will again be the superior. To obviate this difficulty from arising it would seem advisable for Government to either encourage the introduction of a sufficient number of cars, specially designed for high altitudes, or to favour the use of steam cars.

There is a similar loss of power in hot countries during the day-time, but this is partly compensated for by the possibility of using a heavier oil than ordinary petrol, and one which is safer to handle and easier to store.

*Tactics.*—Besides being used for reconnaissance work and the transmission of orders and information, motor cars for M.I. would prove superior to motor cycles as regards the tactical advantage of rapid concentration at a considerable distance. This advantage would be great in the case of an invasion of England, as under a well-organized system some 100,000 men could be rapidly transferred to the coast from London. On account also of their great mobility there would not be the same fear of sending the troops on a wild-goose chase, as they could rapidly be diverted and sent to another portion of the coast if necessary. In fact, they differ from our railways in helping to fulfil the conditions necessary for the strategic defence of a long frontier (*cf.* Table IV.).

The most suitable organization would appear to be the same as for motor cycles, viz. :—(1). Detailing special cars for reconnaissance and orderly duties to different staffs and units, and (2) providing for the transport of technical equipment, and allotting cars (say 10 per cent. in excess of requirements to guard against breakdowns, etc.) to battalions of motor M.I., who would be specially trained for the work required of them.

It would not be necessary to buy all the cars required, they could be registered and called up for service in case of necessity ; special bodies for carrying men could be made and kept in store ; they would not cost much, as they need not be elaborate, a man's kit serving him as cushion. Lorries and traction trains could be registered in the same way, and for home defence some of the lorries could be allotted to batteries to get their ammunition up, guns and teams being sent by train.

Foreign nations are already making considerable use of motors.

*Germany* has a large number of cars, etc., belonging to the army ; these are allotted to staffs and transport units. She has also an automobile volunteer corps for staff work.

On the French frontier are a number of subsidized cars, which will presumably be allotted to staffs and cavalry on mobilization.

Digitized by Google

In addition there are a few special cars fitted with anti-dirigible balloon guns, whose *rôle* will be to chase and bring down these balloons.

Electric four-wheel driven trains have been tried, but so far without any marked success; their heavy transport vehicles are not over reliable, the Fowler trains supplied from England being their best.

*Austria*, owing to bad roads, has comparatively few cars, but all these are registered and liable for service; they would presumably be allotted for staff work and to carry machine guns and ammunition for their motor-cycle infantry volunteers (they have been used this way at manœuvres).

There are a certain number of lorries and traction trains allotted to transport units, and the Government, by sending these round and putting them at the disposal of agriculturists, etc., is endeavouring to advertise them and so create a stock which would be available for war. There is also an automobile volunteer corps for the use of the general staff.

Armoured cars with Q.F. guns have been tried, and so have four-wheel drives in various forms, traction and automobile repair shops, motor ambulances, etc.

*Italy* has a large number of cars allotted to staffs and transport units, and also some light lorries for the cavalry divisions. All cars are registered, as are chauffeurs, who would if reservists be called upon to drive instead of rejoining their particular arm of the Service. There is also an automobile volunteer corps for staff work.

Experiments have been carried out with cars for carrying wounded, electric road trains, automobile repair shops, automobile wireless telegraph stations for use with cavalry.

*France*—after England—has the largest number of cars, but they too are unregistered. Her staffs are supplied with cars, and a number of transport units have them. She has also tried armoured cars with Q.F. guns.

*Russia* has few cars owing to the bad roads. She has tried Q.F. guns on armoured cars, and is thinking of the other uses. In Manchuria an electric road train to carry 4 tons was used.

*Aerial Transport.*—Although flying is in its infancy, it is possible to foresee its great use. Until the problem of flight is thoroughly solved armies have to be content with the dirigible balloon as being the most easy form of flying machine, though probably the one that is least likely to last. These enable us, at present, to cover considerable distances on suitable days, but when the flying machine proper is perfected they may find themselves relegated to the scrap heap, on account of their unwieldiness and the huge target they offer an enemy.

*Dirigible balloons* consist of a cylindrical gas bag, with semi-

Digitized by Google

spherical, or cigar-shaped ends, and with a framework attached to it which carries the engine and car. The gas bag is generally flexible and made of silk or of goldbeater skin, as in England, but Zepellin has a rigid framework of metal covered with silk.

To make up for leakage and the expansion and contraction of the hydrogen, caused by changes in altitude and temperature, the gas bag is supplied with one or more ballonettes, into or out of which air can be pumped as necessary, and so the balloon kept taut. With goldbeater skin ballonettes are unnecessary, as the material itself is sufficiently elastic to keep its shape, besides being more gas-tight.

The gondola, or car, carries the engine and propeller, or propellers, on a rigid framework. This framework is in some cases built into the balloon itself (Zepellin); in other cases it is suspended by ropes (Parseval); and in others, again, a compromise between the rigid and flexible forms of attachment is used (Patrie and Nulli Secundus). The advantage of the rigid form is that the propeller more or less directly drives the balloon, but its disadvantage is that if the ground be touched on landing, the balloon is liable to be torn; with the flexible attachment the latter is unlikely, and in case of a burst the balloon itself tends to act as a parachute.

*Aeroplanes* are in reality kites fitted with a propeller to force them along, and thus give them their lifting power. The box kite form has so far proved the most effective, but there is no theoretical reason why it should always be so; a single plane, on account of its simplicity, may eventually prove to be all that is required. Aeroplanes are so designed that under normal conditions they tend rapidly to right themselves when moved from a stable position. If however they break a wing or rudder, they lose this stability, and in order to make them safe the aeroplanist will have to alter their trim before they reach the ground—a stage which even the Wright brothers have probably not yet achieved.

The first tendency when experimenting, both for dirigibles and aeroplanes, was to get an engine as light as possible, and in some cases even a weight of 2 lbs. per horse-power only has been attained. The Wrights and Parseval however have always advocated the use of a heavier and more reliable engine, since an accident may mean a serious disaster, and so far the French with 100-h.p. engines have not been able to achieve nearly the success that the Wrights have done with a 24-h.p., whilst the latter seem still to have plenty in reserve.

For some unknown reason it is commonly assumed that aeroplanes should be like birds, but this is quite incorrect. The motor car does not resemble a race horse, nor does a ship resemble a fish, although it is true that the imperfect submarine is not unlike a whale, and some monoplanes very like birds.

Digitized by Google

*Hélicoptères* are machines designed to lift the machine off the ground in the first instance by means of a propeller revolving horizontally, and then to move it forward by one working vertically. So far they have not met with much success. There is one at present in course of construction in which a propeller can be moved from the horizontal to the vertical position, or to any of the intermediate positions. There are also planes to enable the machine to raise itself and gradually change the vertical into a horizontal movement, and to become in the final stage an aeroplane pure and simple.

The military uses to which aerial transport might be put in the near future appear to be (1) reconnaissance (for which purpose they could be fitted with a wireless telegraph equipment); (2), communication between two forces which are separated by an enemy or natural obstacle; (3), the attack of captive balloons and other aerial vessels; and possibly (4) to drop projectiles. They could also be used at sea to follow the movements of submarine boats, as these would be visible from a great height.

In order to attack dirigibles and aeroplanes shrapnel is the most likely projectile, as the gas bag is the most vulnerable part of a dirigible, and the propellers and rigging of an aeroplane. The Germans are experimenting with phosphorous bullets to set the gas on fire, and the Italians with bullets linked together to tear big holes.

The dirigible is a very good target if stationary, as it is unwieldy and cannot combat heavy winds, but it can hover and make observations with ease. Its speed is necessarily limited owing to skin friction, and it is particularly vulnerable owing to the inflammable nature of the gas and petrol. Even a spark from the exhaust or ignition of its own engine may cause it to explode.

The aeroplane may be comparatively inconspicuous and fit to travel in all weathers, but it will only be able to circle round a spot, unless some way be found of staying head to wind like a kite. There seems no limit to the speed at which aeroplanes can travel, nor any reason why they should not carry large weights; but they require suitable starting and landing places, or else a catapult such as is used by the Wrights.

The hélicoptère would get over any hovering, landing, and starting difficulties. The tactical uses will probably be the same as for cavalry on land and for cruisers by sea, viz., to obtain information and at the same time to prevent the enemy from obtaining it, and also to carry important messages. Eventually they may be used to transport small bodies of men for raids, but this will hardly be in the immediate future.

For the present the most suitable organization appears to be the

Digitized by Google

same as that of captive balloon and kite equipments, which can be allotted to any force requiring them.

*France*, at various places along the German frontier, has sheds for the reception of dirigibles. She is said to have ordered several Wright aeroplanes, presumably to be so distributed. The French apparently intend to lead the world in the flying-machine industry in the same way as they did with automobiles, and they bid fair to have a long start of other nations.

*Germany* is also installing sheds for dirigibles along the French frontier.

Most other countries are experimenting, to a greater or less extent, with both dirigibles and aeroplanes.

I.—*Time taken by Transport to Consume its Own Load.*

| | Load. Lbs. | Consumes Lbs. per Day. | Consumes Load in Days. | Max. Miles per Day. | Consumes Load in Miles. | Remarks. |
|---|---|---|---|---|---|---|
| Man ... ... | 50 | 4 | 12 | 20 | 240 | (*a*.) |
| Pack horse ... | 200 | 12 | 16 | 30 | 480 | (*b*.) |
| Draught horse ... | 700 | 12 | 56 | 30 | 1,680 | (*c*.) |
| Motor (coal) ... | up to 24 tons | up to 12 per mile | — | 100 | 4,000–5,000 | (*g*.) |
| ,, (oil) ... | up to 24 tons | ,, 6 ,, | — | 100 | 8,000–9,000 | (*g*.) |

II.—*Time and Space for* 1,000 *Men carried by Transport, etc.*

| | Formation. | Interval. Yards. | Yards per Man. | Total Yards 1000 Men. | Miles per Hour. | Max. Miles per Day. | Time to Travel Own Length. | Time to Embark or Disembark. |
|---|---|---|---|---|---|---|---|---|
| Infantry .. ... | 4 abreast | 1 | ½ | 500 | 2½ | 20 | 7 | 0 |
| M.I. ... ... | 2 ,, | 4 | 2 | 2,000 | 4 | 30 | 17 | 2 |
| Cyclists ... ... | 4 ,, | 5 | 1¼ | 1,250 | 8 | 30 | 6 | 1 |
| Motor cyclists ... | 4 ,, | 20 | 5 | 5,000 | 20 | 150 | 6 | 2 |
| Motor cars (4) .. | 4 per car | 20 | 5 | 5,000 | 30 | 400 | 6 | 1 |
| ,, (8) .. | 8 ,, | 20 | 2½ | 2,500 | 30 | 300 | 1½ | 1 |
| Motor buses ... | 40 per bus | 20 | ½ | 500 | 10 | 100 | 1¾ | 5 |
| Railways ... ... | 1,000 per train | 5 min. | 3 | 3,000 | 20 | 400 | 5 | 15 |

Digitized by Google

III.—*Possibility of Motor Transport for a Brigade, R.F.A.*

Normally there are 18 guns, 54 wagons, 7 S.A.A. carts, and 34 G.S. wagons, all horsed, as well as 70 spare horses, length in column of route being 2,500 yards about.

With lorries there might be 18 guns, 18 wagons, all horsed, and 100 spare horses, and 25 lorries, towing 18 wagons and 7 S.A.A. carts as well as carrying the loads of 18 wagons and 34 G.S. wagons, length in column of route being reduced to 1,250 yards about—the lorries would only have about 3 tons apiece.

IV.—*Movement of* 100,000 *Men from London.*

| Nature of Vehicle. | Number of Vehicles. | | Men per Vehicle | Total Men. | Miles per Hour. | Interval. Yards. | Time to Cover 100 Miles on | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | In London | Taken. | | | | | 1 Road. | 2 Roads. | 3 Roads. | 4 Roads. |
| Motor cars ... | 20,000 | 12,000 | 4 | 36,000 | 30 | 20 | 7½ | 5½ | 4¼ | 3¾ |
| Motor buses ... | 1,000 | 500 | 40 | 18,000 | 12 | 20 | 10¾ | 10½ | 10¼ | 10¼ |
| Motor cycles ... | 9,000 | 7,000 | 1 | 6,000 | 20 | 20* | 6 | 5½ | 5½ | 5¼ |
| Lorries, etc. ... | 3,000 | 1,000 | 40 | 36,000 | 8 | 20 | 15½ | 14 | 13½ | 13¼ |
| Lorries .. ... | — | 500 | guns | ammunition | 8 | 20 | 14½ | 13½ | 13¼ | 13 |
| Railways ... | — | — | guns | 560 guns | 20 | 5 mins. | 17 | 11 | 9 | 8 |

* 4 abreast.

V.—*Details for Various Forms of Transport. 2nd Line Transport of a Division* (540 *Tons*).

| | Men. | Animals. | Vehicles. | Miles per Hour. | Max. Miles per Day. | Road Space. Yards. | Remarks. |
|---|---|---|---|---|---|---|---|
| Normal ... . | 1,910 | 3,820 | 436 | 3 | 30 | 6,445 | |
| 140 lorries with trailers (4 tons). | 280 | — | 280 | 6 | 100 | 2,100 | |
| 47 traction trains (12 tons). | 94 | — | 188 | 4 | 60 | 1,410 | |
| Pack horses .. ... | 1,900 | 7,600 | — | 4 | 30 | 45,600 | |
| Coolies .. ... ... | 56,000 | — | — | 2½ | ? | 56,000 | Would take 15 hours to start on 1 path. |

Digitized by Google

VI.—*Loads on Bridges.*

| | Maximum Load. | |
|---|---|---|
| | Per Foot-Run. Cwts. | Per Pair Wheels. Tons. |
| Infantry .. ... ... | 5 | — |
| R.F.A. ... ... ... | — | 1¼ |
| 60-pounder ... .. ... | — | 4½ |
| Motor car ... ... .. | — | 1 |
| Lorry (3 tons) ... ... ... | 6½ | 4½ |
| Motor bus ... ... ... | 6 | 4½ |
| Traction train ... ... | 10—12 | 6—8 |

Digitized by Google

# *THE MAIN UNDERGROUND TELEGRAPH SYSTEM OF GREAT BRITAIN.*

*(Continued).*

*A Paper Contributed by* MAJOR W. A. J. O'MEARA, C.M.G., *Engineer-in-Chief British Postal Telegraphs, at the first International Conference of Telegraph and Telephone Engineers, Budapest,* 1908.

*Translated from the French.*

## CABLING.

The drawing in of the lead-sheathed cable into pipes is carried out to-day practically in the same manner as that adopted in connection with the provision of the first lead-sheathed cable between London and Birmingham. In fact, the only change made has been the introduction of the recently patented wire cable grip (*Fig.* 5), by means of

FIG. 5.—*Cable Grip.*

which the cables are pulled into the pipes. In the early stages of these works this device was not in existence, and a clip had to be fastened on to the end of the cable by means of two screws, for which holes had to be bored through the lead sheath with a gimlet. The conductors had to be forced out of the way, so as to allow the screws to pass through the cable end. The end of the cable with the clip attached was then immersed in melted paraffin wax, which thoroughly filled the interstices caused by the screws. The pulling-in rope was provided with a link to enable it to be connected with the clip fixed to the cable end. This method of attaching the pulling-in rope to cables has now been entirely abandoned, and the wire cable grip is exclusively employed by the British Telegraph Administration. The device has given entire satisfaction when the necessary care is exercised in attaching the grip to the cable so as to ensure that the end of the cable will not rupture and break away should by any chance difficulties be encountered during the passage of the cable through the

Digitized by Google

pipes. The grip is so attached that it may have a bearing on the conductors, and this is achieved by driving back the conductors at the end of the cable with a steel punch, so that they tend to form a terminal knot which the grip can clutch. The sheathing is also uniformly thickened by being closely dressed upon the conductors. The mouth of the grip is drawn forward until it tightly fits the cable, and then secured with a tie of prepared tape. When everything is ready for drawing in the cables, the joint holes in the sections are opened, and a mop made of spun yarn is drawn through the pipes to clear them of any grit or water which may have got into them.

The drums containing the cables are placed almost over the joint holes. The cable grip having been fastened to the cable end in the manner described and the pulling-in rope attached thereto, the operation of paying the cable into the pipe is proceeded with. Six men are employed at the cable drum, one of whom takes his place in the jointing pit and serves the sheathing freely with petroleum jelly; a second man keeps the cable well out from the drum as it is coiled off, whilst four men assist in revolving the drum at a convenient speed and keep the layers of cable from getting too slack. Each man carefully examines the lead sheathing as it passes through his hands, to see that there are no visible defects. This examination has brought to light damage in the lead sheath caused by bad packing, and in such cases the defective cable lengths have been returned to the manufacturers. The men handling the cable are provided with felt aprons and also with leather gloves, to reduce the risk of lead poisoning. It is important to avoid the risk of buckling the cable at the mouth of the pipe during the process of drawing in. In order to avoid this danger the cable should describe a curve of large radius after leaving the drum, and enter the pipe in a horizontal position.

In the early days of the employment of lead-sheathed cables petroleum jelly was used only in connection with the larger sizes of cables, the jelly being intended to act simply as a lubricant to facilitate the passage of the cable along the pipes. During the past few years it has been definitely ascertained that petroleum jelly very effectively protects the lead from chemical attack by street refuse, which finds its way into the joint boxes and pipes, and it is now the practice to coat all lead-sheathed cables with this jelly (see Appendix V.).

At the pulling-in end a crab winch is anchored down to the main pipe by means of a rope, as shown in *Fig.* 6. Four men usually work

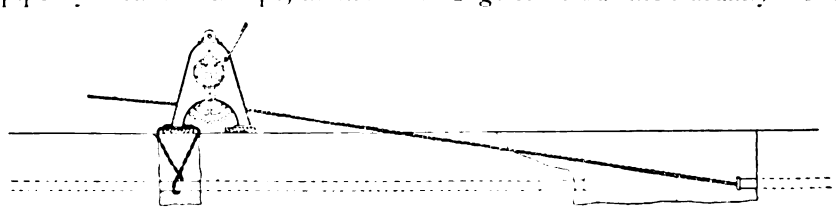


FIG. 6.

Digitized by Google

the winch, whilst one or two men hold the rope taut as it comes off the barrel, and another coils the slack rope on to a drum, so as to keep it free from grit and other foreign substances, and to facilitate its transport.

Before the cable grip was introduced the cable end on which the clip had been fitted had to be sawn off when the pulling-in operation was complete, and the open end sealed.

A considerable time has frequently elapsed before the jointers have been available to join up the several cable lengths drawn into pipes. In such cases the two ends of the cables have been carefully laid side by side in the trench and protected by timbers at the two sides and on top. The ground has then been filled in and the surface made good.

During the progress of the underground work to the north it was decided to draw a cable containing seven screened conductors into the pipe laid between Stafford and Warrington, to be available as a temporary measure in the event of interruptions caused by storms. Fortunately it was not necessary to bring these wires into use in this section. This cable remained in the pipes from February to October, 1903, when the permanent cable was laid between the places named. The temporary cable was then transferred to the pipe line between Manchester and Leeds. As the length of the cable recovered was not quite long enough to bridge the distance between the two towns, eight gutta-percha wires were drawn into the pipe to complete the communication at the Leeds end of this section of the pipe work. This screened cable was required for use after it had been laid between Manchester and Leeds, but, unfortunately, during the process of withdrawal from its first position and the relaying in the second position the copper tape screen had become displaced and had penetrated the paper insulation. In consequence, some trouble was experienced with the temporary circuits established by its means, but this has been overcome and the cable is still in use.

## Cable Jointing.

The operations in connection with the laying of pipes and drawing in of cables already described have occasioned very little trouble and anxiety, but in connection with the jointing of the cables considerable difficulty has arisen, as it has not been possible to find men in the open market with sufficient skill and knowledge who could be entrusted with the very important work of joining together the cable lengths. This difficulty was finally overcome by the department taking in hand the necessary measures to train the men for the work of jointing the conductors and of making the plumber's joints on the lead sheaths.

The number of men employed in a jointing gang has varied to a

Digitized by Google

small extent. A foreman is always placed in charge of the gang, and it has been found convenient to employ two plumbers, four jointers, and four jointers' mates in each gang. In addition to the skilled men mentioned, a certain number of labourers are necessary in order to open the holes, work the desiccator, and act as night watchmen.

The number of joints made in a day and the time taken to make a single joint has naturally depended on the number of conductors in the cables to be jointed. The rate of progress in two actual cases, in which the numbers of conductors in the cables were 96 and 110, has been four completed joints per diem, executed by gangs constituted as above described.

For jointing, a hole 1·8 mètres long by 1 mètre broad by 1 mètre deep is dug, and a narrow trench is made over the end of the pipe line for the purpose of placing a C.I. solid slide in position ready for drawing over the completed cable joint. The general arrangement is shown in *Fig.* 7. The sides and bottoms of the hole are protected by

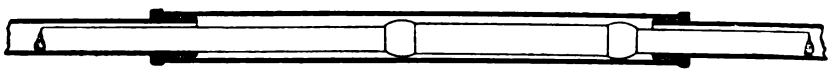


FIG. 7.—*Solid Slide for* 3¼" *Pipe.*

iron sheets, and every precaution is taken to protect the exposed cable end from moisture. Two jointers' tents fitted end to end are placed over the hole, and in rainy weather a tarpaulin is placed over the tents to make them waterproof.

As the joint holes are occasionally situated in permeable soil in the neighbourhood of springs, or under conditions which render it necessary continually to remove the water entering them, and are liable to be flooded suddenly during rain storms, it has been found advisable always to have a lift pump with flexible hose at hand.

The leading jointer first proves the wires for crosses, contacts, and continuity, and, if everything is satisfactory, the length of cable over and above that necessary for the overlap is sawn off.

The lead sheathing is next removed, after passing the lead sleeve over the end on the terminating pipe side of the jointing box. Where terminating pipes are provided at double junction boxes, and it is necessary to use an air cap lead sleeve, suitable sleeves are used, having an air cap towards one end to permit of the sleeve being inserted well into the pipe, and to expose a gap of sufficient length for the joint. The cable is then halved out, that is to say, the layers of wires are separated from each other, being secured by string ties near the lead sheath, and each layer afterwards halved into an upper and lower portion, *Fig.* 8. This process of stripping and halving usually occupies one and a-half to two hours.

All is now in readiness for making the first conductor joint. The practice is to commence with a wire in the centre of the bottom half

Digitized by Google

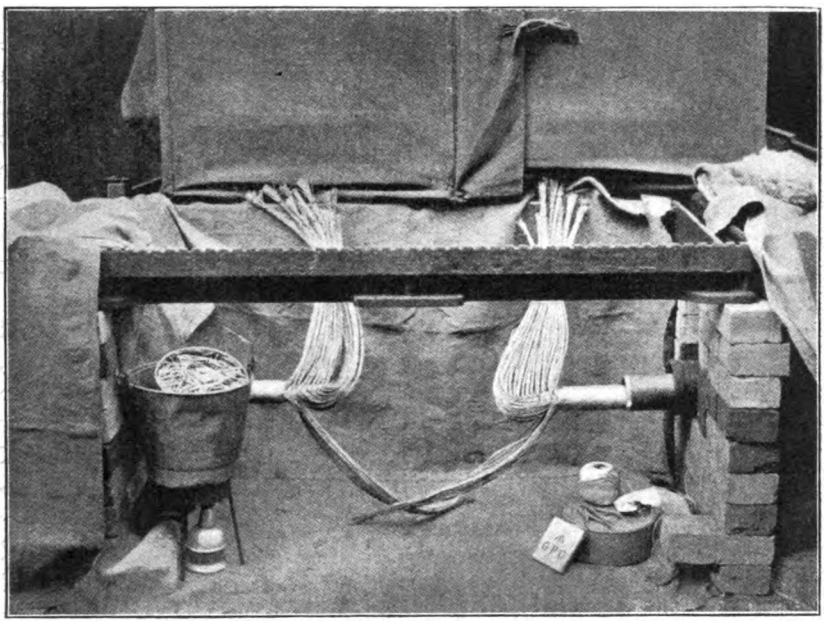


FIG. 8.

of the outer layer of wires and work from the bottom of the cable upwards, and not from the centre of the cable outwards. The latter course is sometimes adopted by a novice, but it leads to waste of time, because it involves the jointing of wires in awkward positions under completed joints.

A competent jointer dealing with a composite cable will handle his wires in the following manner. If he commences with a 4-wire core, he first untwists the paper wrapping and removes the thread common to each pair. Roughly cutting off the surplus length of conductor, he slips on a paper sleeve, unwinds the single wire thread to a point near the sleeve, ties and snaps off the spare length of thread, and turns up the paper insulation. The end of the conductor is now sandpapered and cut to the exact length. Dealing with the other side, the jointer untwists the core wrapping and removes the pair cottons, and, as before, the single wire thread is unwound, tied, and snapped off. An expert workman will tie and snap off the threads with great celerity without weakening the knot or wasting time in handling the cutters, and, generally speaking, it is in the avoidance of unnecessary handling of tools that the skill of a jointer is revealed. If he has to cut the conductors to exact lengths, he will cut several while the cutters are in his hand, and when he is using the soldering iron his work is so arranged that several joints will be soldered before his attention is turned to anything else. This principle extended to a multitude of similar operations results in a considerable saving of time.

Digitized by Google

The wire is next cut to a length which leaves a small space between the two opposing ends, and is sandpapered. A copper jointing tube is slipped for half its length over each of the ends and pinched with the side cutters to hold it in position. The tube and wires are now soldered together with the lineman's solder, with resin as a flux. The paper is now turned down from each side upon the conductor and the sleeve drawn forward. The four joints in each core are made side by side, and the core wrappings from the right and left are brought to an overlap at the paper sleeves, and tied so that the four wires may at once be identified as a complete core.

Turning his attention now to a screened wire, the jointer takes first what will be termed the short end, puts a tie round the metal screen, and tears the latter off neatly at the tie. There are three separate spirals of paper between the screening and the longitudinal paper covering which lies next to the conductor, and of these one is removed at the tie and the other two are bent back, whilst the paper next to the conductor is also torn off at the tie. Turning then to the other side of the joint to deal with the long end, the screen is tied and torn off as before, two spirals of the paper are turned back, and the third removed. The paper sleeve is drawn over the wrapping lying next to the conductor. The end of the conductor is sandpapered, cut to length, and the copper tube put on and pinched. The short side is also fitted in the tube and pinched, and the joint is soldered as previously described. The spirals of paper from the short side are re-wrapped for about 1·25 cms., and the sleeve from the long end brought forward to a position where it overlaps the longitudinal wrapping on the long side and the re-wrapped spiral on the short. The spirals on the long side are then re-wound as far as the paper sleeve, where one is torn off short and the other continued over the sleeve to the far end, where it is secured by a tie.

A capable man will joint his wires in such a way that he works always as it were on a bulging surface. If the conductor joints are completed in a way that tends to form a sort of well or hollow, the free handling of wires requiring to be jointed in the hollow is greatly hindered.

The two most prominent difficulties which impede a jointer are awkward positions as regards the joints and the presence of water. Better joints and more speedy work can be expected when a man can sit square with the cable and have the joint well under his hands. The presence of other cables and pipes sometimes prevents access from above, and the cable must be jointed from below, the jointer lying underneath the cable.

Both the multiple-twin and quadruple-pair cables present some initial difficulty in jointing. Ordinary twin cables are jointed straight through, pair to pair. With the multiple-twin cable care has to be

Digitized by Google

taken to joint different coloured pairs together in each core, as each of the different coloured pairs is laid up with a distinctive lay or twist. Thus, in a core of eight wires, the

White pair is joined to the green pair
Red „ „ „ blue „
Green „ „ „ red „
Blue „ „ „ white „

This method equalizes the length of "lay" over a long section. Similar precautions have to be taken with the quadruple-pair cable. The pairs forming a quadruple core are laid up with different colours, and each core has a different colour. In jointing it is necessary that dissimilar coloured cores be jointed together, and also that pairs of dissimilar colour in each core be jointed together, and that the position of pairs diagonally opposite to each other in the cores be unaltered. By this means the pairs which are laid up with unequal "lay" are made equal in length, and therefore equal in resistance over a long section. If these precautions were not taken, two bunched pairs would be of unequal resistance over a long section, the electrical balance would be upset, and successful working and super-imposing would be impracticable.

After completing the conductor joints, the lead sleeve is pulled again over the gap, and after being dressed down upon the cable sheath, is closely wrapped at each end with prepared canvas and india-rubber strip successively.

A joint is thus made temporarily watertight and reasonably secure until such time as a plumber is available, but the interval between conductor jointing and plumbing should be reduced to a minimum. When this officer is ready, the joint is carefully dried by means of a charcoal brazier, and before wrapping the whole joint with paper a small piece of silvered glass is held over the conductors in order to detect any moisture. Should there be any appearance of vapour on the glass the drying by means of a brazier is continued. When the drying has proved satisfactory, the plumber takes possession and proceeds to fix the lead sleeve.

Needless to say, an awkward position affects a plumber adversely as well as a jointer, and in some circumstances considerable experience is needed to effect a thoroughly sound wiped joint. The time occupied in the various duties incidental to plumbing is as follows :— Cleaning out the hole, half an hour ; preparing the sheathing and lead sleeve, three-quarters of an hour ; wiping two joints on the one lead sleeve, one hour. Caulking down the manhole lid usually occupies another half an hour.

Digitized by Google

## DESICCATING.

When the underground cable was laid between London and Birmingham, no very reliable means were at hand to test the efficiency of the plumbers' joints on the lead sheathing, but since the completion of this section of the main underground scheme the desiccator pump has been introduced into the Telegraph Engineering Department, and every plumber's joint is tested with air pressure by its means.

After five or six cable lengths have been joined up, the exposed ends of the cable are fitted with lead caps having air nozzles. A pressure gauge is connected to one of the nozzles and a pressure gauge and desiccator to the other (*Fig.* 9). The compressor is then started,

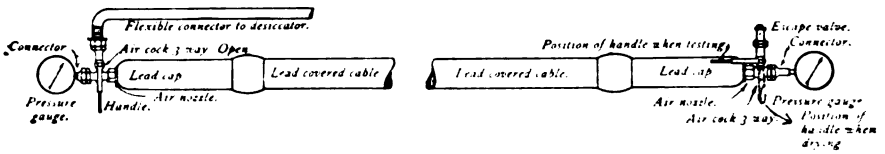



FIG. 9.—*Testing and Drying of Lead-Covered Air Space Cables.*

and when the pressure gauges at the extremities of the cable indicate 20 lbs. pressure the plumbers' work is tested by smearing soapsuds over the wiped joints. If any flaw is discovered, the joint is entirely re-made.

After the pump has been stopped and while the pressure is still in the cable, observation is kept on the pressure gauges, so that any fall due to an imperfection in the sheath of the cable may not escape notice.

An air-pressure test of each completed 5-mile section is also made. The ends of the cable are fitted as shown in *Fig.* 9, and pressure maintained until the gauge at the distant end indicates 20 lbs. The three-way cock is then closed to prevent the air leaking back through the desiccator and the pressure allowed to equalize throughout the cable. A note is made of the time when the gauges read alike and another reading taken 24 hours later. During this period the fall of pressure must not exceed 5 per cent.

## FAULTS.

Although, as I have explained, the cable lengths have been tested before being despatched from the factories, some trouble has been experienced during the progress of the work in dealing with manufacturers' faults after cables have been drawn into the pipes, and a great deal of inconvenience was caused by the discovery of faults arising from the existence of metallic filings in the insulating paper used in the cables delivered between Exeter and Taunton in the early part of this year, with the result that seven faulty cable lengths had

Digitized by Google

to be returned to the manufacturers. As this period of the year unfortunately coincided with the termination of the Parliamentary financial year, it was quite impossible to replace these lengths in the short time available before the 31st March, and in consequence a considerable amount of the money voted for this work was unexpended on the date mentioned and had to be surrendered. In order to prevent the possibility of faults of this nature remaining undetected when the cables are tested at the factories, it has been decided to test the cables at a pressure of 1,000 volts instead of 600 volts, as was the practice until the beginning of this year.

It has usually been possible in these cases to localize the earth faults by means of the loop test to within about ·2 mètre of the point at which they have occurred.

I may say that our experience up to the present time with the lead-sheathed cables provided on our main routes has been very satisfactory. The cables have not certainly been entirely free from interruption since they have been brought into use; a few faults have developed which may be traceable to faulty workmanship; in a few cases cables have been accidentally damaged by workmen employed by the road authorities, and in two cases, where the route passes over coal workings, the roadway has subsided, though in only one of these cases did interruption to the circuits result. The first of the subsidences referred to above occurred in 1907 south of Hamilton, in Scotland, where from 36 to 45 mètres of the roadway sank some 3 mètres below its original level; the pipes were drawn, but the cable remained intact, although it has no doubt been somewhat stretched. In the case of the second subsidence, which occurred north of Hamilton in March, 1908, the lead sheath of the cable was ruptured, causing a complete interruption to the traffic.

A schedule (Appendix VI.) is attached, giving particulars relating to the cases in which actual interruptions to the circuits working in the cables have been caused.

An eminently satisfactory feature in the situation arises from the fact that in the original section of the cable between London and Birmingham, in which 125,476 conductors' joints and 1,651 plumbers' wiped joints are involved, only three interruptions have occurred since June, 1900, when the cable was first brought into use, and the cost of removing the faults has only amounted to 2,350 francs.

## Description of Circuits Working in Cables.

It will have been observed that the first of the three types of cables used on the northern route possesses no screened conductors, this type not then having been introduced. With high-voltage Wheatstone circuits it has not been found possible to secure successful working simultaneously on neighbouring unscreened conductors for a

Digitized by Google

distance exceeding 20 kilomètres. It would thus be necessary to work Wheatstone on loops through the first section of cable, and then insert a repeater, the signals being repeated to a single aerial conductor earthed at both ends (*Fig.* 10).

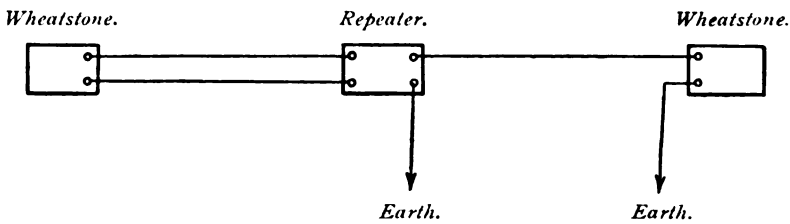



FIG. 10.

The majority of the circuits in use are however wholly in the underground cable, and in such cases loop-working is adopted throughout (the repeater not being required), whilst an additional circuit, key-worked, is superimposed on the loop, as shown in *Fig.* 11.

Between London and the various large cities on the route of the cables described there are working, on loops, 38 circuits, made up as follows :—

12 Wheatstone Duplex,
10 Hughes Duplex,
3 Wheatstone Simplex (for news work),
9 Double-Current Sounder Duplex,
4 Quadruplex (one with Wheatstone),

and upon 26 of these loops additional double-current duplex circuits are superimposed. This gives a total number of working channels of 133, and additional superimposing is possible up to the total number of loops available, viz., 38.

*Fig.* 11 gives a diagrammatic representation of the apparatus connections necessary for superimposing a key-worked duplex circuit upon a cable loop, which may be a duplex-worked Hughes or Wheatstone, or a quadruplex.

The two conductors of the loop and the loop apparatus are shunted at each end of the circuit by a high non-inductive resistance, from the centre of which is taken the line connection of the superimposed or "plus" circuit. Thus the conductor of the superimposed circuit consists of the two wires of the loop in parallel, with the addition of resistance at each end. In the case of lines under 240 kilomètres in length each of the superimposing coils or arms has a resistance of 3,000 ohms, and on lines over 240 kilomètres in length 5,000-ohm. coils are used. Each arm of the superimposing coils is shunted by a condenser, which acts as a signalling condenser for the

Digitized by Google

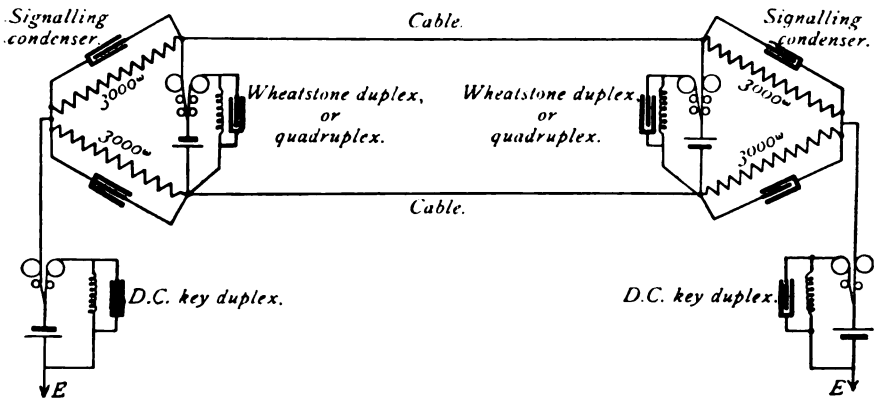



FIG. 11.—*Plan of Loop and Superimposed Circuits.*

plus circuits, increasing considerably the range of working of the circuits. The capacity of these condensers is 10 mfs. for circuits over 240 kilomètres in length, while for lines of less than 160 kilomètres no signalling condenser is required.

From an examination of the theoretical diagram of the circuits (*Fig.* 11) it will perhaps be noticed that the battery of the superimposed circuit ensures on the two conductors equality of potential at all adjacent points so long as the conductors are throughout equal in resistance and capacity.

Similarly the points of connection of the superimposed circuit with reference to the loop battery are of equal potential, being in the exact centre of the two electrically parallel circuits traversed by the loop currents.

Owing to the non-effective circulation of the current in the superimposing arms, the arrangement entails some waste of current from the loop batteries at each end of the circuit. This is however a small matter compared with the advantage obtained by the increased number of channels.

In the Western Cable the following circuits are working from London, in some cases for the whole distance, and in others for the greater part of their lengths :—

| | |
|---|---|
| Wheatstone Duplex ... ... ... ... | 4 |
| Quadruplex ... ... ... ... ... ... | 10 |
| Double Current Duplex ... ... ... ... | 25 |
| Double Current Simplex ... ... ... ... | 8 |

It should be understood that in addition to the above many long-distance circuits are working for a part of their length through the cable, and are brought out at various points and continued therefrom by means of aerial conductors. The question as to the final allocation of circuits in the cable is still under consideration, and many changes are in course of progress.

Digitized by Google

## UNDULATOR WORKING.

One of the first experimental uses made of the Western Cable was to make up a direct circuit, London to Cork (Ireland), worked by means of the undulator, the repeater formerly in use for ordinary working being in the meantime cut out of circuit.

The circuit comprised on the English side 192 kilomètres of underground cable and 269 kilomètres of aerial wire; 120·64 kilomètres of submarine cable; and on the Irish side 192 kilomètres of aerial cable. With simplex conditions, a speed of 130 words per minute was obtained. At duplex however disturbing effects from neighbouring wires in the submarine cable led to a reduction in the speed of working to 86 words per minute.

The extreme sensibility of the undulator renders it very valuable on long circuits subject to a sudden fall in insulation. This is shown by the fact that duplex working between London and Cork, a distance of 893 kilomètres (with long lengths of underground and submarine cable), is practicable without a repeater, even when simplex working only is possible on ordinary Morse circuits with the aid of a repeater.

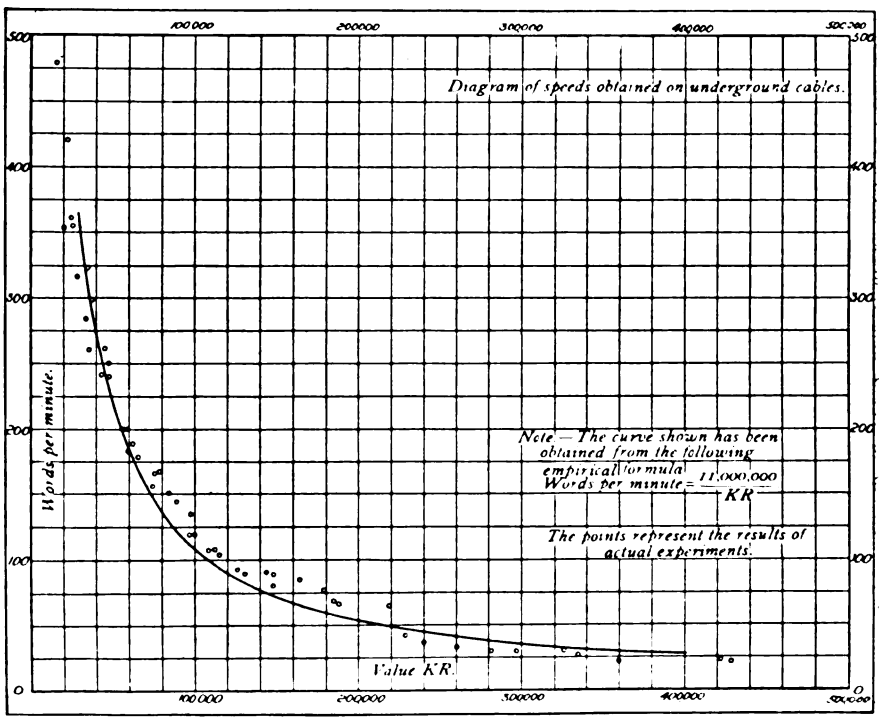



FIG. 12.—*Diagram of Speeds obtained on Underground Cables.*

Digitized by Google

## Speed Tests.

I have thought it desirable that some information be given upon the actual working speeds which have been secured upon cable circuits. For this purpose the curve diagram, *Fig.* 12, may be referred to.

The curve has been obtained from the empirical formula :—

$$\text{Words per minute} = \frac{11{,}000{,}000}{KR}$$

and shows the number of words per minute for successive KR values up to 400,000. It should be observed that these trials were made under simplex conditions.

The results of some speed trials under both simplex and duplex conditions on single-screened conductors may be of interest, and are given in the following Tables. In each case the voltage was 125 :—

| Length of Line in Kilometres. | Total K in mfds. | Total R in ohms. | KR. | Speed. Sx. | Dx. |
|---|---|---|---|---|---|
| 187 | 12·75 | 1465 | 18680 | 353 | 231 |
| 243 | 16·57 | 1903 | 31530 | 300 | 195 |
| 386 | 26·269 | 3017 | 79253 | 153 | 103 |
| 467 | 31·82 | 3656 | 116330 | 111 | 71 |
| 666 | 45·34 | 5208 | 236140 | 51 | 34 |

With unscreened loops the following values were obtained :—

| Length of Line in Kilometres. | Total K in mfds. | Total R in ohms. | KR. | Speed. Sx. | Dx. |
|---|---|---|---|---|---|
| 187 | 7·17 | 2301 | 14560 | 390 | — |
| 243 | 9·32 | 2639 | 24590 | 316 | 200 |
| 386 | 14·77 | 4184 | 61794 | 182 | 122 |
| 467 | 17 90 | 5069 | 90740 | 125 | — |
| 666 | 25·50 | 7222 | 184150 | 54 | 35 |

Digitized by Google

## CONCLUSION.

The annual maintenance cost incurred in connection with the upkeep of these cables, which includes attention to joint boxes, test pillars, and the removal of the faults referred to, averaged out for the twelve months ending 31st March last at .5 *franc* per kilomètre of conductor, which compares favourably with the average annual cost of the similar service in respect of open wires, which amounted for the same period to 4·1 francs per kilomètre (5s. 3d. mile).

When a large number of wires are involved, as is the case with the main routes described in this Paper, the capital cost of underground construction per kilomètre of conductor is approximately the same as that of overhead construction, and when the greater freedom from interruption of the underground conductors, as compared with that of open wires, and also the probable longer life of the underground plant is considered, clearly there is much to encourage the rapid extension of the main underground network of telegraph wires.

In conclusion * * * * * much of the work originally proposed has been carried out, and there seems a likelihood that at an early date we shall have immunity from storm interruptions so far as our main telegraph lines are concerned.

Digitized by Google

## *APPENDIX IV.*

### PILLAR TEST BOXES.

In order to facilitate fault testing in long sections of main cables, test pillars accommodating cable connection boxes are fixed at suitable points.

The cast-iron pillar itself is merely a protective case to prevent accidental damage to, or unauthorized interference with, the cable connection box inside.

The pillar stands on a foundation of brickwork, 22·5 cms. thick, built on a bed of concrete 15 cms. thick, to which it is firmly bolted down.

In some cases it is necessary to fix a joint box close to the pillar, in order to change the type of cable or to accommodate inductance coils.

The plinth of the pillar test box may be used to lock down one side of the joint-box cover. When the joint boxes are intended to contain apparatus which might be tampered with, special covers fitted with a locking arrangement are supplied.

Enamelled caution plates, with cuphead bolts for fixing, are issued for use in districts where disfigurements of the pillars by bill posting or other means is apprehended.

A pillar test box is not necessarily erected over a line of pipes, but is invariably fixed in such a position as will ensure it against damage due to the incidence of road traffic.

*Bonding at Test Pillars.*—The pipes at a test pillar are bonded together, and an earthplate 75 cms. × 75 cms. buried in damp soil near the pillar test box and connected to the cable connection box by a soft copper wire. The stranded conductor is placed under one of the nuts holding the lid of the box on the air space side.

## *APPENDIX V.*

### PETROLEUM JELLY.

The jelly used for lubricating and protecting from electrolytic action the lead cables of the British Post Office has a melting point of 51° C., and is a well-refined yellow jelly. As a check upon the quality, the viscosity at 65° C. is determined by Redwood's Viscometer, and we specify that 50 cubic centimètres shall take not less than 200 seconds to pass through the instrument. A jelly giving a value appreciably lower than this is liable in hot weather to flow off the cable during the operation of pulling into the conduit, and it consequently becomes inefficient as a protective coating. In practice the jelly is applied liberally to the surface of the lead-covered cable as the cable passes into the conduit, and, approximately, 31·5 kilogrammes of jelly per kilomètre is required for a cable of 6·8 cm. diameter.

Digitized by Google

# APPENDIX VI.

*Schedule of Faults in Main Underground Cables since Commencement of Work on System.*

| Description of Cable. | Locality of Fault. | Length of Section Affected. | No. of Wires in Cable. | No. of Wires Stopped. | Date and Duration of Stoppage. | Approx. Cost of Repair. | Nature and Cause of Fault. |
|---|---|---|---|---|---|---|---|
| | | Kilomètres. | | | | Francs. | |
| *Main Northern Cable*—London to Glasgow. Type—Air space paper core. Work commenced 1897. | 34 kilomètres north of London. | 34 | 76 | All | March 04 ½ hour | 925 | Defective jointing. |
| | Weedon, Northants, 118 kilomètres north of London. | 70 | 76 | All | July 00 | 850 | During a severe thunderstorm lightning set fire to the leads of a test hut, and thus destroyed the leading in cables. |
| | Shirley, 10 kilomètres from Birmingham. | 37 | 76 | All | August 06 10 hours | 575 | A workman in digging a hole for a pole accidentally broke the pipe and drove a pickaxe through the cable, which became flooded for a length of several feet. |
| | Hamilton, Scotland ... | 18 | 97 | All | March 08 3 days | 2,500 | Owing to a considerable subsistence due to coal workings, the pipe was fractured at one place and the cable damaged. The pipe joints were drawn apart to the extent of about ½" for a distance of about 150 yards. A temporary interruption cable was laid above ground whilst the cable was being repaired. |
| *Main Western Cable*—(Commenced December, 1904; completed London—Taunton, July, 1908). Type of cable—Air space paper core. | 6 kilomètres west of London. | 10 | 169 | 6 | 1 May 08 2½ hours | 250 | A pickaxe was accidentally driven into the cable by a workman. |
| | 6 kilomètres west of London. | 10 | 169 | 80 | 27 July 06 60 hours | 1,250 | A heavy thunderstorm occurred whilst joint was open. The cable lay between two hills, and water flooded manhole and damaged the cable. The majority of the wires were working after 25 hours. |
| | 67 kilomètres west of London. | 59 | 104 | All | 29 April 08 55 hours | 2,500 | A pickaxe was accidentally driven into the cable by a road workman. |

Digitized by Google

# *THE R.E. HEADQUARTER MESS.*
## (*Continued*).

*By* LIEUT.-COLONEL B. R. WARD, R.E.

General Sir Arthur Thomas Cotton, K.C.S.I. (1803—1899),* is the only representative of the Madras Engineers commemorated in the Mess. Many distinguished Engineers have at various times done duty in the Southern Presidency, but none has probably left so lasting a mark upon the country of his adoption as Sir Arthur Cotton.

All his soldiering was done in 1824 as a subaltern in the first Burmese War, where he led the storming parties against seven forts and stockades. After the war he was posted to the Public Works Department, and in 1828 he was appointed to the separate charge of the great irrigation works on the river Cauvery. The fertile districts of Tanjore and Trichinopoly were entirely dependent on an ancient system of irrigation channels which were in existence before the British occupation of Southern India, but in 1828 the system was seriously endangered by the increasing tendency of the waters of the Cauvery to flow down the Coleroon, thus deserting the southern branch and its dependent irrigation channels. Cotton's investigations were carried out with great care over a series of years, and resulted in the preparation of a scheme consisting of two large dams, or anicuts, which were built in the winter of 1835–6, during the brief season of the cessation of freshes in the river.

"They were built at a most critical time, for in 1837 a failure of the rains took place, which, without the new works, would have caused immense loss to the people and to the Government. The great utility of the works was at once realized. The principal collector of Tanjore writing to the Board of Revenue in 1838, declared that there was not an individual in the province who did not consider it (the upper anicut) the greatest blessing that had ever been conferred upon it, at the same time expressing his conviction that 'the name of its projector would, in Tanjore, survive all the Europeans who had been connected with it.'"†

Ten years after the construction of the Coleroon works, Cotton laid before the Madras Government a project for building an immense

* *Dictionary of National Biography*, Supplement, Vol. II., p. 63, and *R.E. Journal*, 1899, p. 187.

† *Dictionary of National Biography*, Supplement, Vol. II., p. 64.

Digitized by Google

dam across the Godaveri River. The stream is $3\frac{1}{2}$ miles wide at the point selected, but the actual waterway is reduced to $2\frac{1}{4}$ miles by the presence of three islands in the stream. "Even so it was a stupendous work, the Dowlaishwaram branch of the anicut being alone of greater length than the two Coleroon anicuts put together."*

The work occupied five years in construction, and proved as successful as the first one. The district, which formerly was continually in a state of extreme poverty, is now one of the most prosperous in India.

On completion of the Godaveri work, Cotton proposed a third scheme of irrigation by the construction of a dam on the Krishna River. This scheme was actually planned by Colonel Sir Henry Lake and constructed by Major-General Orr, but the allotment of funds for its construction was undoubtedly due to the enthusiastic advocacy of Cotton.

The following extract from the records of the Government of Madras show how highly the stupendous irrigation works originated and carried out by Sir Arthur Cotton were appreciated by the Government :—

> If we have done our duty, and have founded a system which will be a source of strength and wealth and credit to us as a nation, it is due to one master mind, which, with admirable industry and perseverance in spite of every discouragement, has worked out this great result. Other able and devoted officers have caught Colonel Cotton's spirit, and have rendered invaluable aid under his advice and direction, but for this creation of genius we are indebted to him alone. Colonel Cotton's name will be venerated by millions yet unborn, when many who now occupy a much larger place in the public view will be forgotten.†

o o o o o

If further testimony is required to the immense value of his work, the following figures give a good idea of the benefit it has bestowed on the Madras Presidency. During the great famine of 1877, 4,000,000 persons are supposed to have perished in the more or less unprotected districts of Madras, whilst not only were there no deaths from famine in the districts protected by his work, but in addition surplus food was exported sufficient to save 3,000,000 lives elsewhere.

Sir Arthur Cotton lived to the great age of 96, and up to within a short time of his death still took a keen interest in Indian affairs, noting with delight how God had blessed the British rule in India. "If any man had written when I went out," he wrote to a friend some three years before his death, "expressing a hope of anything

* *Dictionary of National Biography*, Supplement, Vol. II., p. 64.
† *Dictionary of National Biography*, Supplement, Vol. II., p. 65.

Digitized by Google

approaching the present state of things, he would have been thought the greatest fool in India."

Lieut.-General Sir Andrew Clarke, G.C.M.G., C.B., C I.E. (1824—1902), throughout an extraordinarily varied career, worked as few men have ever worked, with a singleness of mind and clearness of aim towards the building up and consolidation of the Empire. "The story of his life is the record of a man who from his first start in the world was determined to succeed, who felt that he had in him the ability to get on, who seized the opportunities that offered themselves, and by his strenuous character made a name for himself in a succession of very diverse services to the State."*

As a subaltern he served his apprenticeship under two famous Colonial Governors—Sir George Grey in New Zealand, and Sir William Denison in Tasmania.

In 1853 he was appointed Surveyor-General of Victoria, and before sailing for England in 1858 he had been offered the Premiership of the Colony. After a short period of service in England he was sent to the Gold Coast, where he was mainly occupied in the preparation of a report in which he collected a great deal of valuable information. The report was published in July, 1864 and was considered the best description of the coast in existence up to the time of the Ashanti Expedition of 10 years later.

From 1864 to 1873 he was Director of Engineering and Architectural Works at the Admiralty. The construction and launching of the Bermuda floating dock, a visit to Egypt and a report on the Suez Canal, a scheme for manning the Navy, the construction of a new dock at Malta, docks at Portsmouth, Chatham, and Cape Town, the Alderney and Portland Breakwaters, and a joint report with Sir John Hawkshaw on Dover Harbour, were the result of these nine years of strenuous work. The honour of a K.C.S.I. and the following letter from the First Lord of the Admiralty show how highly his services in connection with the Navy were appreciated.

"*From* The Right Hon. G. J. Goschen.

"*Admiralty, 20th September*, 1873.

"Dear Sir Andrew Clarke,

"I cannot deny myself the pleasure of repeating in writing what I expressed to you when we parted on Thursday, that in losing your services at the Admiralty I feel that we are sustaining a heavy loss, and that personally I shall be most sorry to miss you from amongst us at Whitehall. I have been greatly impressed by your conspicuous devotion to the public service, and by the energy which you throw into everything you undertake.

* *The Life of General Sir Andrew Clarke, G.C.M.G., C.B., C.I.E.*, by Colonel R. H. Vetch, C.B., p. 8.

Digitized by Google

"I will not repeat what has been stated in our official letter to you as to the sense entertained of your engineering ability and the great works which have been constructed under your auspices. Let me only say that you have most worthily filled what was a most important post when you first succeeded to it, but which you have rendered still more conspicuous and useful to the State by the way in which you dealt with it. Wishing you every success in your future career,

"I remain, yours very truly,

"GEORGE J. GOSCHEN."*

It is not possible to do more than touch on the many high appointments held by Sir Andrew Clarke after this date.

From 1873 to 1875 he was Governor of the Straits Settlements, where perhaps the most important work of his life was effected, viz., the establishment of ordered Government under British supervision throughout the Malay Native States which had hitherto been in a state of anarchy. From 1875 to 1880 he was member of Council of the Viceroy of India. In 1881 and 1882 he was Commandant of the School of Military Engineering, and from 1882 to 1886 he was Inspector-General of Fortifications. His work in all these high offices bore the impress of his vigorous and original mind.

Sir Andrew took a great interest in all Corps Memorials, the portraits of Sir William Denison and Sir Lintorn Simmons were painted on his initiative, and it was at his suggestion that Mr. Onslow Ford, R.A., was selected as the sculptor of the Gordon Memorial at Chatham. "Never was a committee more fortunate in its choice of an artist. He threw himself into the work *con amore*, and thought of nothing but getting as near as possible to his ideal.

"After making some sketch models of Gordon in British uniform of the conventional type, Mr. Ford had an inspiration. This was to seat General Gordon, dressed as Governor-General of the Soudan and Field Marshal in the Egyptian Service, on a camel, and to depict him in the act of overawing Suleiman and the Arab slave dealers by his sudden and solitary appearance at Shaka and by the personality of his commanding presence. There was some hesitation on the part of the committee at this bold proposal and departure from conventionality. Some thought the camel would draw attention from the man, others that there was no precedent for a camel statue, but, backed by the support of Sir Andrew Clarke and an enthusiastic secretary, Mr. Onslow Ford's brilliant idea prevailed. Opposers and hesitators gave way, and the beautiful bronze statue of Gordon on the camel was the result."†

The bronze bust of Gordon in the north annexe is another of the

* Vetch's *Life*, p. 117.
† Vetch's *Life*, p. 291.

Digitized by Google

Corps Memorials carried out by Sir Andrew's committee, and is also the work of the same distinguished sculptor. Sir George Clarke, who served under Sir Andrew when he was Inspector-General of Fortifications, has written a preface to Colonel Vetch's interesting biography. The preface closes with the following words :—"Readers of this volume will recognize a life of exceptional public usefulness worthy of record, and they will not fail to realize the intensity of interest and the wide scope of the careers which our Empire can bestow upon its favoured sons. Those who knew Sir Andrew Clarke will never forget his great kindliness and broad sympathies. Those who served under him will cherish the memory of a chief who was always considerate, always inspiring, and always open-minded. In the intensely complex affairs of our national life he played a notable part, and it is by reason of labours such as his—often unknown and unrewarded—that we move, however slowly, towards the light."*

The bust of Sir Richard Harrison bears the following inscription :—

COLONEL RICHARD HARRISON, C.B., R.E.,
WHEN ASSISTANT ADJUTANT AND QUARTERMASTER-GENERAL
AT ALDERSHOT, 1881—1886.

HE BECAME QUARTERMASTER-GENERAL OF THE FORCES
IN 1897, 1898,
AND INSPECTOR-GENERAL OF FORTIFICATIONS
IN 1898—1903.

There is no need to go into detail with regard to Sir Richard Harrison's career. We are fortunate in having him still among us, and he has found time to give us an interesting account of his eventful life in the autobiography recently published by Smith, Elder & Co., and reviewed in the March number of the *R.E. Journal*.

The bust of Vauban, now kept in the Ladies' Reception Room, stands on a wooden pedestal, on which is written the following extract from the *Eloge* of Fontenelle on the famous Engineer and Marshal of France :—

*VAUBAN.*

*Un sens droit & étendu, qui s'attachoit au vrai par une espèce de simpathie, & sentoit le faux sans le discuter, lui épargnoit les longs circuits par où les autres marchent. . . .*

*Il a fait travailler à 300 places anciennes, en a fait 33 neuves, a conduit 53 sièges & s'est trouvé à 140 actions de vigueur. . . . Il a eu la gloire de ne laisser en mourant qu'une fortune médiocre. . . .*

*C'étoit un Romain qu'il sembloit que notre Siècle eut dérobé aux plus heureux tems de la République.*

*Fontenelle.*

* Vetch's *Life*, p. 14.

Digitized by Google

Fontenelle was perpetual Secretary of the Academy of Sciences from 1699 to 1741, and wrote in his official capacity the *Histoire de l'Académie des Sciences*, containing extracts and analyses of the proceedings, and also the *Eloges* of the members. The death of Vauban in 1707 was the occasion of the eulogy quoted above, in the transcription of which the old 18th century French spelling has been retained.

Below the 18th century French inscription is an English 19th century record to the following effect: —

Taken from the French Engineer's Office at Antwerp in May, 1814, and respectfully presented to the Inspector-General by Lieut.-Colonel Carmichael Smyth, Commanding Engineer with the Army in Flanders.

This bust of Vauban is one of the most interesting as well as being the oldest war relic in the possession of the Mess. To Engineers of the 20th century the name of Vauban is no longer one to conjure with, yet in the long list of men distinguished in the profession of military engineering there is certainly no name that so well deserves commemoration.

The features are those of Vauban at the height of his fame in the 17th century. The work is that of a French artist of the 18th century, the inscription on the base reflecting something of the homage and admiration felt for the great engineer and soldier when he breathed his last in 1707. His first military service was in 1653, and in 1703 he attained the rank of Marshal of France, being the first French military engineer to attain this high distinction.

An English Plutarch, writing parallel lives of French and English heroes, would probably select Burgoyne as the English Vauban. In sound judgment and common sense the two men were not dissimilar. In length of active military engineer service they both surpassed all their contemporaries; and Burgoyne, like Vauban, was the first military engineer of his nation to attain to the rank of Field Marshal. Neither of these distinguished men ever commanded an army in the field, but Vauban and Burgoyne will surely always remain supreme in the hearts of all military engineers of their respective nationalities as the embodiment of the highest ideals attainable by the Corps de Génie and the Royal Engineers.

Digitized by Google

# *MEMOIR.*

## *LIEUT.-GENERAL JAMES CROFTON.*

*By* MAJOR W. BROADFOOT, LATE R.E.

LIEUT.-GENERAL JAMES CROFTON, Retired List, Royal (late Bengal) Engineers, died at his house, 12, Westbourne Square, London, W., on November 22nd, 1908, in his 83rd year. His chief commissions were as follow :—Captain, August 13th, 1858; Major, December 9th, 1864; Lieut.-Colonel, March 1st, 1867; Colonel, March 1st, 1872; Major-General, December 31st, 1878; Lieut.-General (Hon.), on retirement. He was the third son of Lieut. Morgan Crofton, R.N., whose grandfather was created Baronet in 1801. His mother was Helen Elizabeth, daughter of Col. H. O'Hara, of O'Harabrook, co. Antrim. Born in Harcourt Street, Dublin, on May 7th, 1826, James Crofton was educated privately and at Cheltenham College, which he joined on the day it was opened, and was the first to pass from the college into Addiscombe. Thence he qualified for the Bengal Engineers, his commission as 2nd lieutenant bearing the date December 9th, 1844. Ten Engineers were appointed on that day; of them, Major-General W. W. H. Greathed, C.B., Major-General F. T. Haig, and General J. T. Walker, C.B., may be mentioned; whilst of those who may be called contemporary, General Sir Alex. Taylor, G.C.B., Colonel J. H. Dyas*, Major-General Ralph Young†, Sir Andrew Clarke, G.C.M.G., C.B., Sir John Stokes, K.C.B., and Sir Richard Sankey, K.C.B., Crofton's cousin, acquired distinction.

Whilst at Chatham he had the misfortune to be seriously hurt on board a steamer on his way *viâ* London to Ireland. There was fog on the river and he was caught in a collision with another steamer which ran into them; an arm was crushed and his collar bone was broken. The arm was not properly set, and consequently he never had the full use of it; though the damage did not interfere with his work, in after life he suffered from its effects.

Crofton arrived at Calcutta on December 16th, 1846, by which date the first Sikh War was over and the expedient was being tried of

* *R.E. Journal*, April 1st, 1899.
† *R.E. Journal*, January 1st, 1898.

Digitized by Google

governing the Punjab through a Council of Regency under the guidance of a British Resident. Like other Engineers, he did duty for a short time with the Bengal Sappers and Miners, and in 1847 he was appointed to the Public Works Department.

In those days there were few Engineer officers available, and the recently annexed Cis-Sutlej territory—extended in 1849 to the rest of the Punjab—demanded attention; consequently service in the grades of Assistant was either very brief or altogether dispensed with, and men commenced their careers as Executive Engineers instead of spending four or five years as Assistants, as was usual some 15 or 20 years later. Yet these fortunate persons never seemed to realize what they owed to this long start, which placed them in the highest positions when still young, and in which they remained serene (for there was no limit of tenure) till prepared to retire or till removed by some other cause.

In Crofton's case there is some ambiguity as to the dates of various civil appointments, but the following note of his services is near enough not to materially mislead. The names of the offices held have been changed, which does not tend to lessen the confusion, but records show that in December, 1849, he was serving as Assistant Superintendent on the Western Jumna Canal.

Early in 1850 he marched from Delhi to Lahore in order to commence surveys for the Bari Doab* Canal. This great work, like many other irrigation canals in India, was preceded by a native-made channel called the Hasli (Huslee), a work which though often faulty in detail yet showed, as is attested by Lieut.-Colonel Napier,† a remarkable degree of judgment in construction, for it carried water—intermittently no doubt—from the foot of the Himálaya to the gardens of Amritsar and Lahore more than 100 miles distant. Napier, who in 1850 was Civil Engineer in the Punjab, or, as we now term the office, Chief Engineer, quickly saw the wide field for improvement opened by annexation, and promptly sent as many officers as could be spared to make a reconnoitring survey of the Bari Doab, and to take levels in order to send in a project for extended irrigation. Besides the hope of profit at some future period, there were at the moment wandering about the country great numbers of disbanded Sikh soldiers whose employment was politically expedient; consequently there was every disposition on the part of Government to advance the scheme. This was entrusted to Lieut. Dyas, whose talent, zeal, and industry were justly acknowledged, and whose right-hand man and dear personal friend was Lieut. Crofton.

Work was pushed on in spite of defective maps and surveys, and the project was submitted to the Board of Administration in October,

* Bárí: contraction of Beás Ráví. Bárí Doáb = the land between the two rivers, Beás and Ráví.

† Afterwards F.M. Lord Napier of Magdala.

Digitized by Google

1851. In due course sanction was obtained, but experience showed that revision of the estimates was necessary. Crofton carried this out whilst work was in hand, and in 1856 the revised estimate was submitted.

Next year progress was arrested by the outbreak of the Mutiny; funds were curtailed and the labourers were reduced. A considerable number of them however found congenial employment as soldiers, being enlisted as pioneers under command of Lieut. H. W. Gulliver and marched to Delhi, where they looked forward to fighting and plunder. They distinguished themselves greatly and formed the nucleus of the 32nd Sikh Pioneers. These events and the transfer of several officers caused delay which at the time was deeply deplored; experience however has shown that the evil was mitigated, for errors, then unavoidable, would have been more frequently repeated if work had not been interrupted.

On March 1st, 1858, Crofton married Mary Susan, daughter of Sir Robert Montgomery, then Judicial Commissioner of Lahore, a distinguished officer prominent during the Mutiny in disarming native regiments and in adopting wise measures for the suppression of revolt, who afterwards became Lieut.-Governor of the Punjab. To Mrs. Crofton fell the ceremony of admitting water to the canal on April 11th, 1859, work having been pushed on night and day for three weeks in order that Crofton—who had to leave that day on furlough—might be present. Whilst at home his wife died at Kingstown, near Dublin, on December 22nd, 1860; a year later he was back in India, and by January, 1862, had returned to Lahore. From May, 1863, till September, 1864, he was employed as Superintending Engineer on the Eastern Jumna Canal, on surveys for the Sirhind Canal, and was then transferred to the charge of the Punjab canals in place of Dyas, who was sent to the North-Western Provinces.

During Crofton's tenure of office in the Punjab, work increased greatly; irrigation was developed, drainage received attention, old channels were remodelled, and surveys for new projects were made. The irrigation service was consequently strengthened, and the present writer, who met Crofton in January, 1865, was in 1868 appointed to the Secretariat of the Punjab Government to assist in driving the coach.

In 1867 Crofton married, as his second wife, Clara Elizabeth, daughter of Capt. Edward Lake, R.N., and cousin of General E. Lake, C.S.I., Financial Commissioner of the Punjab, and by her had 10 children, six of whom survive.

Crofton held office in the Punjab till 1874; on his departure the Lieut.-Governor (the late Sir Henry Davies, K.C.S.I.) issued a complimentary order expressing "his high appreciation of your services. He desires especially to record his sense of the great value of your matured experience and good judgment in all matters connected with

Digitized by Google

irrigation, your thorough mastery of the details of canal management, whether professional or administrative, and your indefatigable industry in carrying out the duties of your office. Your name will be associated with one of the most important irrigation works in progress—the Sirhind Canal—the design of which is your own and the success of which, his honour trusts, will be commensurate with the conscientious care which you have bestowed upon the undertaking from first to last."

On leaving the Punjab, Crofton was appointed Inspector-General of Irrigation and Deputy Secretary to the Government of India, the highest appointment in the canal department. He held this post till retirement from the Service in January, 1882, when he settled in London, first at Clapham Park and afterwards at Westbourne Square, Paddington. There Mrs. Crofton died on December 16th, 1890. So long as strength remained Crofton employed himself in local business; he served eight years on the Board of Guardians and as a member of several religious committees; he also was treasurer of Sunday schools, of the Church Missionary Society for Paddington, and of a working man's club in the Harrow Road.

Throughout life Crofton was a deeply religious man, who, whilst holding his own views strongly, was yet tolerant to all forms of Protestant worship. Though in appearance delicate (he was about 5′10″ in height and weighed about 8 stone), he had great vitality, whilst his endurance, either in the saddle or on the office stool, left nothing to be desired. His health and memory began to fail a few years ago, but till recently he was able and pleased to see old friends In business matters he was easy to work with, and was much liked by the heads of other departments with whom he was brought in contact. Courteous in manner, grave, but with a saving sense of humour, and patient, he was devoted to his work, from which indeed he seldom sought relaxation. That with him did not take the ordinary form of games or sport, for which he showed no desire, but rather was found in camp life, inspecting canals all over the country, and escaping to the wilds from the distractions and entertainments at headquarters. Similarly after retirement his leisure was chiefly devoted to good works, and he has now, after a long and useful life, entered into rest.

Digitized by Google

# *TRANSCRIPT.*

## AN APPRECIATION OF AUSTRIA-HUNGARY'S MILITARY POSITION.

From the *Neue Militärische Blätter* (Berlin), 28th December, 1908.

ALTHOUGH the hope that peace will not be disturbed still—and rightly—exists, there are manifold evidences at hand which impel us to think of the possibility of an armed conflict.

The Austro-Hungarian War Department must reckon with the extreme case, and make its arrangements in such a manner that, if in the course of this year it should come to open hostilities, action shall be taken immediately and with the superiority in *personnel* and *matériel* which is required in order to assure rapid and decisive tactical blows.

We must recognize in the measures of the War Department the steps necessitated by the development of the external political situation. Even late in the summer, long before the annexation had been announced, the Sarajewo Army Corps and the detachments in Southern Dalmatia had been moved into positions which would enable them to energetically oppose any sudden attempt at a rising by Montenegro and Servia. They were supported by the fortified positions, which were brought up to a war scale of mobilization, so as to secure the strategical deployment of the forces destined for a campaign. Later on followed the double necessity of not only taking measures in Bosnia and in the Herzegovina to prevent raiding by bands, but also of strengthening the defence of the border along the Drina-Danube-Save barriers.

The respective measures were, (1) the organization of punitive corps, composed by raising the peace strength of all the troops garrisoning the territory formerly occupied, and by this means bringing the XVth Corps to a fighting strength of 50,000 men, and (2) by retaining the junior reservists. Servia's obvious preparations for war next required further measures, and all reservists were accordingly retained, which was equivalent to increasing the peace strength by about 100,000 men. Besides this, it is contemplated—in case the situation requires it—to call up more sections of the reserve and militia. The preparation of the southern front as a base of operations, and the despatch of more troops for observing the frontier, went on hand in hand with the above measures so that the formation of a new division of two mountain brigades became necessary. The fighting strength of the XVth Corps now amounts to 110,000 men.

As regards the details of these measures, it can be said that this display of military strength by the Monarchy is not only appropriate to the actual

Digitized by Google

present state of affairs, but is comprehensively worked out for all possibilities which could arise in the course of the development of the international situation, and for which the Monarchy wishes to be prepared.

In estimating the strategical relation of the Monarchy to Servia and Montenegro, it should be emphasized that the course of the boundary line makes an advance on convergent lines—and in the case of Montenegro even a concentric advance—possible. Yet the length of the frontier, the lack of efficient communications, and the obstacles which the local conditions oppose to military undertakings must be regarded as most weighty considerations.

### AUSTRO-HUNGARIAN ZONES OF STRATEGICAL DEPLOYMENT.

As zones of strategical deployment against Servia, the areas north of the Danube barrier come under consideration, especially the lower Banat and Syrmien, and also the area from Zvornik to the junction of the Drina and the Save. The lower Banat—the area west of the railway line Weisskirchen-Temesvar up into the Danube-Save angle—is almost throughout a well-cultivated plain, with numerous large towns providing good billeting accommodation. The communications are for the most part good roads, but the numerous cart-tracks are of little use in wet weather, as the top soil is clay mixed with black earth. Five sets of rails lead into this area along lines of deployment, but, with one exception, they are only local branch lines of somewhat small capacity. The Danube can also be used as a line of strategical deployment, but there is so little water in the river in the winter that only slow moving shallow-draught boats can be used. Syrmien (Szeben)—the area west of the reach of the Danube from Slankamen to Semlin as far as the Bosut—is, in its northern portion, rich in large towns securing favourable billeting conditions, and has considerable resources at disposal. Communications are not particularly favourable, as there are only four good roads running north and south. Four lines lead into this area, including the main line Budapest-Neusatz-Semlin. The Danube and the Save can also be taken into consideration for the strategical movement into this area, but their utility in war would be limited to transport of materials and reinforcements. The conditions of strategical deployment are most favourable at Pancsova, where four good roads and two lines of railway lead to the river.

The Danube has special importance as a frontier barrier; it is 450 to 1,200 mètres wide, 4 to 18 mètres deep, and slow moving. The banks are high and broken, the approach to the water's edge is, to a great extent, rendered difficult by low-lying swampy ground, and by the lack of good communications available at all seasons. Of great importance are the passable protecting dykes, which also lead partly inland and could be used for the advance and for the transport of bridging material. These dykes are only found on the northern bank and are guarded by the river watchers, who are connected by telephone both with each other and with the river conservancy authorities. From December to February the Danube is generally at its lowest, and it is at its highest from April till June. One disadvantage must be noted, namely, that the southern

Digitized by Google

bank is the commanding one for long reaches, and therefore Austro-Hungarian undertakings will have to be made mostly within sight and range of the enemy's bank; still as regards this the appearance of the Danube flotilla can ensure protection. Only one heavy bridge offers secure communication over the river, but bridging material is available in many places on the river itself, and besides this a sufficient store of material is available from the steamship companies. Materials can be brought up on the river itself, and the numerous islands, the "war islands" at Semlin, the islands at Pancsova, Semendria, and Gradiste, as well as those downstream from Bazias, appear favourable for the construction of a bridge. For a light military bridge, 9 to 20 bridging trains, and 10 to 25 hours preliminary work are necessary, but bridging operations are only possible in still weather. As regards the convoying of materials, it is to be observed that a convoy from Budapest to Orsova takes four days, and in the reverse direction eight to nine days.

From Semlin westwards, the Save forms the boundary. This river is 300 to 750 mètres wide, 2½ to 9 mètres deep, and slow moving and downstream from Samac, the Servian bank is the commanding one. The already considerable obstacle of this volume of water is appreciably strengthened by the character of the valley, which not only makes approach difficult in wet weather, but also makes it impossible in parts at high water. For the capacity of the Save as a transport line, similar conditions obtain as in the case of the Danube.

### Conditions of Strategical Deployment on the Drina.

The area west of the Drina from Zvornik to the point where the Drina flows into the Save, contains any areas which could be taken into consideration for the assembling of large forces only in the lower Posavina—which is wooded and boggy in places—or in the valleys of the Drina and in the Spreckopolje: otherwise there are only small scattered groups of places, which are but little suited for the billeting of troops. As lines of strategical deployment there are two railways available, one by Esseg and Brcka, and the other by Brod, but both end two marches from the frontier. As a continuation the roads radiating from Brcka towards the important communication-junction Bjelina and the communications leading from Brcka and Dolna Tuzla against Zvornik could be utilized. To a limited extent the Drina—connecting with the Save—can be turned to use as a line of transport.

Further south there are no places of assembly of any magnitude on the frontier itself; the small basins of Vlasenica and Srebenica only come under consideration for the billeting of the advanced frontier detachments. The single large place of concentration is Sarajevo, which should afford room for three or four divisions within its surrounding ring of modern fortifications. It is however two to four days' march from the boundary. Besides this there are only very poor settlements, which could only be used for the billeting of small detachments. Somewhat more favourable conditions prevail in the valleys of the Drina at Visegrad and in the mountain country in the basins of Kotusica and Glasinac.

Digitized by Google

The small gauge railways from Brod to Sarajevo, Metkovic to Sarajevo, and Sarajevo to Visegrad lead into this zone; beyond these, only roads, which are certainly in excellent condition, come under consideration. The observation and security of the frontier is made easier by the Drina, which is 100 to 200 mètres wide, and in its lower reach requires three to seven bridging trains (of 64 mètres length) for its bridging. This river is difficult to cross, and the most important crossings are protected by fortifications. At Foca (Fotcha) there are three defensible barracks, at Visegrad one defensible barrack and two open batteries, at Zvornik one old fortress with subsidiary works. Further inland the places of assembly referred to before, Vlasenica, Srebenica, further on Gorazda, Rogatica, Hanpod, Romanja, and Praca, are protected in the form of fortified garrisons: Sarajevo, finally, is fortified as a base and *point d'appui* by a girdle of 18 kilomètres extent, consisting of defensible barracks and gun emplacements, and by an entrenched camp.

### SERVIAN ZONES OF STRATEGICAL DEPLOYMENT AND OBJECTIVES.

We find in Western Servia near the frontier the following areas for the concentration of forces for the offensive movement across the Drina, as apparently planned, viz.:—(1), The plain on the Drina downstream from Loznica, which—though situated directly on the frontier—is well adapted as regards considerations of space, billets, and communication for large forces; (2), the basin of the upper Jardar Valley; and (3) Valjevo and Uzice-Pozega, each distant two or three marches from the frontier, though limited in area, with indifferent resources, and only relatively favourable conditions for billeting. It is important to note that between these areas of concentration and the frontier lies a range of hills difficult to pass, with few roads, and heavily wooded; this circumstance would greatly influence a forward movement to the Drina on the one hand and on the other an Austrian advance. The communications for an advance on the frontier are not unfavourable, especially as regards the area Janja-Loznica, into which three good lines of communication lead, radiating towards the Drina. Intercommunication, in the zones of concentration and communication with the country in rear, is by several lines of road which join in Valjevo, and make it thereby an important junction of communications and an intermediate objective for Austria. For crossing the Drina the Servian bridging material at hand at this time would hardly suffice, only two whole and five half bridging trains being available. It is not known however whether these have been since added to, and the procuring of material on the Drina and the Save can be stopped by Austria's Danube flotilla.

As Servian zones of concentration in the interior, the following come into consideration:—Kragujevac, Cacak, the valley basins on the Morava, and Nis. But the last-named areas are at such a distance from the frontier, that they can only be considered in the case of a defensive course of action being pursued from the very first, and this in no way would correspond with the objects sought by Servia.

The Nis-Belgrade Railway is at disposal as a line of strategic deployment

Digitized by Google

against the Danube front. It is a normal gauge single track line of small capacity, with heavy curves and insufficient facilities for watering. When this is considered in connection with the insignificant peace traffic, which makes thorough-going practical instruction of *personnel* impossible, it depreciates the serviceability of the line on mobilization.

### Servian Objectives.

As the Servian Army is too weak for an offensive move across the Danube-Save barrier, only Sarajevo can well be regarded as the objective of an offensive stroke, as the loss of this as chief town would particularly injure Austria-Hungary's prestige in the country, and would swell the insurrectionary forces. Irrespective of its resources and billeting accommodation, this zone is also of great importance in that the best communications from the country in rear meet here, viz., railways and roads by Brod, Mostar, and Bugojno, the latter joining up with the steamship route from Trieste and Fiume at Metkovic. For this reason reinforcements can easily be concentrated in this place. The important line of reinforcement could be cut by a raid on the line Brod-Doboj-Sarajevo. The most sensitive points of this line are the railway and road bridges at Doboj, Maglaj, Zepce, Zenica, and in addition the railway runs for the most part on the eastern bank, and the Bosna River offers no absolutely secure protection.

From this statement it is clear that Sarajevo can serve as main objective, somewhat in unison with a Montenegrin offensive, while the railway communications referred to can be considered as the secondary objective.

### Conditions for an Offensive Move by Austria-Hungary.

Servia's network of communication is well laid out for any advance either across the Danube, or in a north and south direction, but as regards the lateral communications across the country, there is only one road running right through, a noteworthy fact when considering the supply of war material.

West of the Morava there are two to three means of communication fit for wheeled traffic, and which are important for concentrations of troops, leading from Valjevo and from Kragujevac into the basins of Cacak, Uzice-Pożega, Kraljevo-Krusevac in the south, and into the valleys of the Western Morava. From the Bosnian frontier several lines, fit for wheeled traffic, lead into the zones of concentration already referred to, but these lines are somewhat isolated in consequence of the nature of the mountains. By this converging of the communications from the northern as well as from the western front of the country, supreme importance is attached to the towns of Valjevo and Uzice, as well as to the Morava Valley, with Cacak, Kraljevo, and Krusevac as the foci of an Austro-Hungarian offensive conducted across the Danube and the Save. For the prosecution of an offensive across the Danube, the broad valley of the Morava is centrally situated and stretches right across containing one railway and two, or in places, three roads to Nis affording a very favourable line of advance. Nis is thus of particular

Digitized by Google

strategic importance as an important junction of communications, from which the great connections with Belgrade, Sofia, and Kumanova, and the roads to Pristina and into the Timok Valley, can be commanded.

In the Timok district only two good communications, suitable for wheeled traffic, lead from the Danube to Zajecar.

On account of the system of communications and the geographical conditions already described, it may be supposed that in the case of a war between Austria-Hungary and Servia, the main Austrian force would be assembled in the lower Banat and deployed in the Morava Valley against Nis, and that, parallel with this action, separate and supplementary action would be pursued on lines through Belgrade, Sabac, Lozdica-Bijelina, Rogatica-Visegrad, with Kragujevac-Krusevac-Nis as the objective beyond Valjevo-Uzice.

A diversion by Turkey, for whose entry into the Servian and Montenegrin alliance Servia has striven so hard, is only conceivable against the last-named Austrian line of operation, to which the Turkish areas of concentration of Sjenica, Novibazar, and the Kosovopolje give favourable conditions. The union of Turkey with the Servian-Montenegrin alliance would however force Bulgaria to march on Adrianople, both on account of the obligations entered into with Austria-Hungary and also out of interest for her own preservation. The Servian fortifications on the Austro-Hungarian frontier are of no importance. For an Austro-Hungarian offensive it is worthy of notice that the resources of the country are insignificant, and that therefore an extensive system of supply is required, and this, owing to the military character of the population, renders strong measures for its security necessary.

### THE POSITION OF THE HERZEGOVINA AS AN AREA OF CONCENTRATION AGAINST MONTENEGRO.

The geographical peculiarities of the "Karst" (Eastern Alps), such as great poverty of resources, lack of water and fuel, lack of billeting accommodation, extremely unfavourable sanitary conditions, are particularly strongly developed in the Herzegovina and Dalmatia, as also in the Cernagora (Montenegro). These conditions render the subsistence of troops difficult, and necessitate an extensive system of supply which presupposes, on the one hand, a well-developed network of communications, and on the other—more especially in view of the proximity of an opponent prepared for immediate action—numerous strong points which serve for the defence of the frontier either as places of strategical deployment or as intermediate bases and points of support.

The military measures of the Austrian War Department had therefore in the first place to be directed to the construction of communications, and before all things to the construction of efficient communications with the Monarchy. This resulted in the laying down of the small gauge railway Brod-Sarajevo-Metkovic-Trebinje-Zelenika (Castelnuvo) and its branch lines, and in the improvement of the state of the harbours in Southern Dalmatia. So too the lines of road to Avtovac, Bilek, and Trebinje from the Narenta were constructed by utilizing natural low levels

Digitized by Google

and joining up with the railway and the harbour of Metkovic, and these lines were connected up with each other, as well as with the best harbours, by the roads through Neum, Mostar, Slano, Nevesinje, Ragusa, and Avtovac. For pushing up forces direct from Sarajevo on the Drina into Eastern Herzegovina, a road, suitable for wheeled traffic from Sarajevo to Kalinovic, and the bridle path Foca-Cemernosattel-Gacko, were laid down over the Krblijina, Zargoje, and Morinje.

### Austro-Hungarian Lines of Operation and Objectives.

Montenegro is divided geographically into two parts, one the Cernagora—with the regions on the Scutari Lake—and the other the Brda. The former territory embraces the most thickly inhabited and climatically most favourable parts of the Principality, and affords, though in a limited degree, almost the only means of subsistence for the defenders, while it alone possesses good communications with other countries, on whose material assistance Montenegro depends. The Brda is an extremely inhospitable country. Thus for an Austro-Hungarian offensive, only the Cernagora need be considered, and in particular the district of Nicsic and the lower Zeta. Cettinje as the capital cannot become the objective, as it does not possess the importance ordinarily belonging to capitals. The frontiers of Montenegro only bear the character of obstacles along the Tara-Piva gorge—1,000 mètres deep and in the rocky mountain peaks of the Maglic—the Vlasulja, and the Lebronik, and in the Trebijncica gorge; in other parts the frontier is open, and from the ends of the Duga across the Orjen towards Bar, it is formed for the most part of ridges of hills 200 to 500 mètres high. At Cattaro, and partly also along the Herzegovinian boundary, the border line runs on this side of the ridges, and thus affords the Montenegrins tactical advantages. The communications leading from the interior of the Monarchy to Montenegro, unite from Foca, Avtovac, Bilek, Trebinje, and the Krivosije in Niksic with those from Cattaro, Budua, and the coast of Spizza-Bar at Rijeka; both these junctions of communications therefore acquire the importance of objectives. They are the Montenegrin centres and are connected by a good road through Podgorica, which facilitates movement of troops by the defender.

An Austrian offensive would have to reckon not with a most extremely tenacious opponent, extremely adept in defence, but also with the difficult peculiarities of the country. According to former experiences of war, this opponent can only be overcome when his country is occupied piece by piece, and so each new move of this mobile opponent in the rear of invading corps is checked. Beside strong garrisons and extensive use of fortification, mobile reserves would have to look after the security of the communications and nip in the bud every attempted concentration of the enemy.

### Montenegrin Areas of Strategical Deployment.

Montenegro can concentrate her forces in the depression of the Zeta Valley and in the small areas of concentration lying along the frontier in the middle of the desolate rocky alpine tract, namely, Grahovo, Bukovica, Cettinje, Rijeka, Virpazar, and in the coastal plain of Bar (Antivari).

Digitized by Google

From here communications lead across the mountain ridges, forming the boundary through the Dugafurchen, then by Trepca Grahova Cettinje (road and bridle path), Maini Sutomore, which could partly be made fit for wheeled traffic.

A Montenegrin offensive with Mostar as objective, as well as co-operation with Servia across the Sandjak of Novibazar, or Foca-Kalinovik, is sorely prejudiced by lack of means of reinforcement. An offensive against Spizza would offer much the better chances, as this line of operation is of little length, and some resources are to be had on the coast. In an undertaking against Spizza, Montenegro would have to reckon on a counterstroke by the Austro-Hungarian fleet.

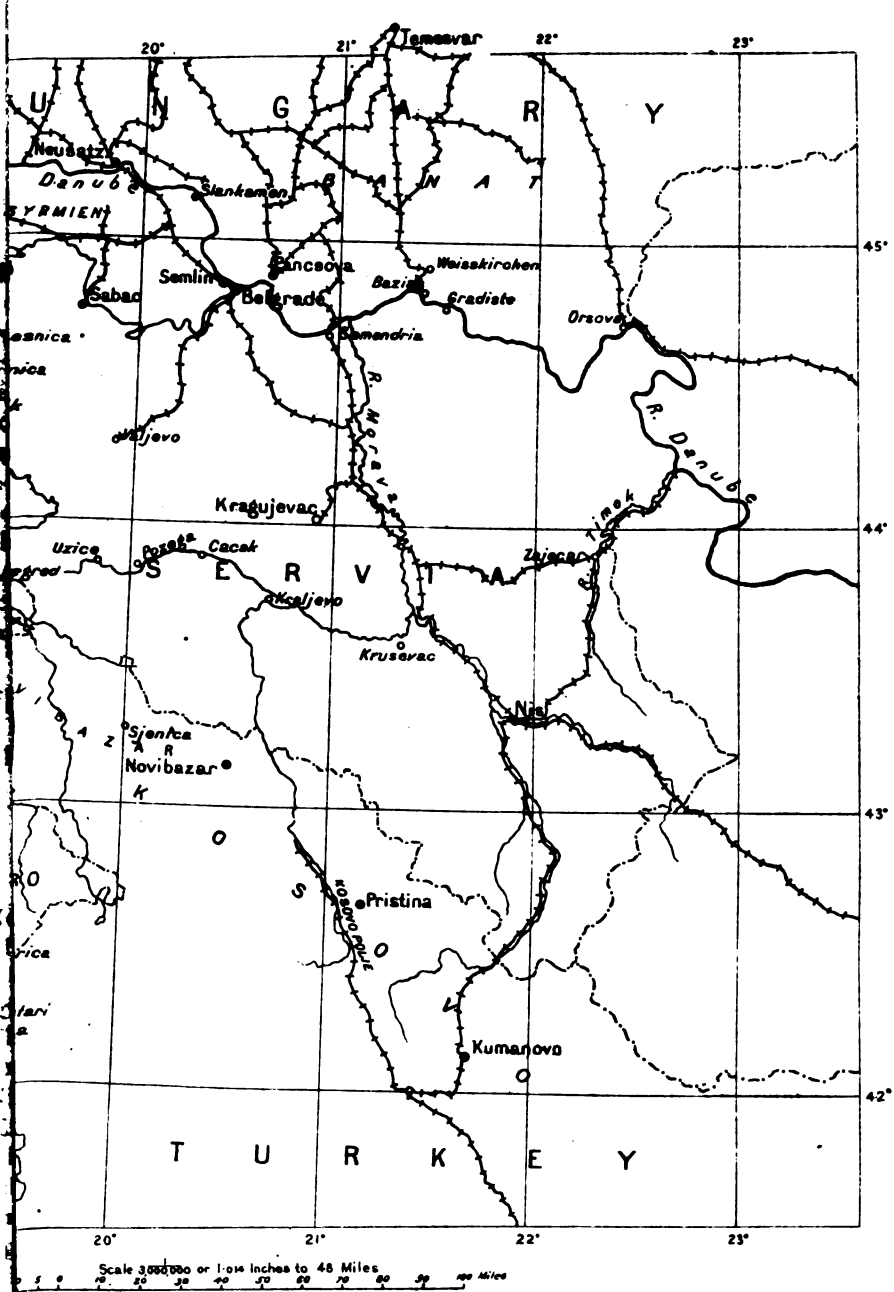
Montenegro has to reckon with a concentric invasion by Austria-Hungary's forces, and as the Austrian force would be increased by 100,000 men, the Principality has practically no chance of assuming the offensive. All the fortresses on the Herzegovinian frontier, such as Bilek, Trebinje, Gacko-Avtovac, Kalinovic-Trnovo, have been furnished lately with garrisons up to a total of 10,000 men, and with a large supply of war material.

It is worth while expressly emphasizing at this point the fact that Austria-Hungary has no intention whatever of moving out from her waiting position; the military measures taken are only measures of prevention. A great Power of the standing of the Austro-Hungarian monarchy could not allow matters to come to such a point as to expose herself to defeat by such small States as Servia and Montenegro.

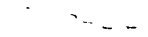
That Turkey would take up arms against Austria can only be regarded as very improbable. A move by Turkey is only conceivable from the Kosovo, and from the Sandjak of Novibazar, but as observed at the commencement, the Austro-Hungarian War Department has taken sufficient precautions even for this certainly improbable eventuality.

E. G. WACE.

Digitized by Google




Digitized by Google



Digitized by Google

# *NOTICES OF MAGAZINES.*

## Bollettino della Societa Aeronautica Italiana.

*December*, 1908.

The first article is a continuation on the subject of the winds in Italy, and deals with the south and western corner. These compilations are of very great use to those making a study of the subject, but are of no special interest to others.

In the second article there are a few notes on aeroplanes, dirigible balloons, and light motors; also an excellent outline drawing of the German military balloon—"Dirigible Gross-Basenach." This is described in the last copy. The photographs of the motors are of little value, being merely as seen from the outside.

The third article gives the rules for the Monaco Meeting, 24th January to 24th March, 1909. This meeting is only for heavier-than-air machines, which can be started in any way preferred. The course to be run seems a dangerous one over the sea, from the Mole at Monaco to Cape Martin and back, a distance of about 6 miles. The course must be run three times on three different days. Any number of trials may be made, and the prize will be given calculated on the basis of the least time in completing the course during the three best trials.

| | |
|---|---|
| 1st prize ... ... ... ... | £3,000 |
| 2nd „ ... ... ... ... | £1,000 |
| 3rd „ ... ... ... ... | £400 |
| Entrance ... ... ... ... | £4 |

Note is made of the following prizes open to aviators:—

The "Ruinart" prize open to the 1st of January, 1910—£500. To be run only on Saturdays and Sundays, crossing the Channel either from England to France or *vice versâ*.

The "Gordon-Bennett" Cup of £500, and three prizes amounting to £1,000 for aeroplanes probably on a circular course.

Nice has arranged for a meeting in which the prizes amount to £2,000.

The fourth article has a good description of the Wright Brothers' machine, which is of course well known now.

In the fifth article calculations of the resistance of ogival-headed dirigible balloons. Numerous experiments made in the United States by the French authorities demonstrate that the "coefficient of shape" is proportional to the mean value of the sine of the angle which the tangent at the extremity of the projectile forms with its axis.

The exact shape of the head of the projectile appears to be of less

Digitized by Google

importance than the proper formation of that portion which is in rear of the greatest diameter.

The sixth is a useful article with photos on the construction of a cannon for use against balloons. The author says that the cannons already in the Service are quite insufficient. It will be necessary to have a number of special cannons at favourable points, bridges, harbours, docks, etc., and also to have movable armament on automobiles. He is of opinion that to reconnoitre accurately from a dirigible balloon you should not be more than 10 kilomètres off, or more than 5,000′ high. He lays down the following conditions which govern the construction of a special cannon :—

It must have unlimited power of traversing horizontally and vertically, and can be mounted on a pivot on a fixed base or on a wheeled carriage.

Photos are given of the 6·5-cm. Krupp cannon, which is ingeniously situated so that the wheels can be placed with their axles pointing to the trail of the cannon, allowing very rapid traverse of the whole machine. Special arrangements must be made for the recoil.

The damage to a balloon can be either perforation of the outer envelope, leading to large escape of gas, or possibly ignition of the gaseous mass. Damage may also be done to the motors, to the screw, to the controlling planes, and other fragile parts, and also to the ballonnets of the semi-rigid and non-rigid systems. The maximum damage will be done if the shell bursts inside the balloon, for the envelope will be rent to ribbons and the remains will crash to the ground.

The author further suggests that some chemical substance might be carried in the extremity of the projectile itself which would ignite the hydrogen on contact.

Observation being of the greatest importance, accurate observation instruments must be used. Mechanical aids to calculation are of the first importance, in order to correct the ranges while the balloon is well within range.

The Krupp gun throws a projectile which leaves a trail of smoke behind it, and this makes the trajectory easy to observe. It weighs as much as an ordinary field gun.

There is also a special supplement devoted to spherical sporting balloons, but this is of no particular interest.

'J.E.C.'

---

INTERNATIONALE REVUE ÜBER DIE GESAMTEN ARMEEN UND FLOTTEN.

THE DEFENCE OF COASTS AND HARBOURS ACCORDING TO THE TEACHINGS OF THE RUSSO-JAPANESE WAR.—Capt. Bracht, of the Prussian Foot Artillery, has published a series of interesting articles on this subject in recent numbers of the *Militär Wochenblatt*, basing his observations chiefly on a paper on coast armament by M. Treidler in the *Russian Artillery Journal*. The following extract is interesting :—

Digitized by Google

"As is proved by the history of maritime wars, especially during the last 50 years, the defence of coast fortresses possesses a much greater importance from the point of view of the results of the campaign, than the defence of those situated in the interior. The loss of a maritime fortress often decides the fate of the whole campaign, as was the case at Sebastopol, Charlestown, Alexandria, and Port Arthur. Now the defence of such fortresses as these rests almost entirely on the action of the coast artillery, which has to perform the following tasks:—

1. To prevent the hostile fleet from gaining possession of the fortress by main force, *i.e.*, from forcing the entrance of the harbour after having reduced to silence the coast batteries of the defence.

2. To afford an assured refuge to its own fleet in the event of the enemy obtaining command of the sea.

3. To prevent the enemy's fleet from bombarding at a long range the stores, magazines, docks, etc., of the fortress.

4. To prevent the hostile fleet from basing itself on neighbouring harbours, either for operations at sea or for disembarking troops, and thus to render a blockade of the fortress from the land side impossible."

The author considers that though existing coast defences are generally sufficiently powerful to repel the attacks of an enemy's fleet, still they are rarely pushed sufficiently far out to prevent the effective bombardment of the place from ranges of 9,000 to 11,000 mètres (say 5½ to 7 miles). It must not be forgotten that the range of naval ordnance is constantly increasing, and consequently coast batteries should be sited even further away from the nucleus than present conditions make absolutely essential.

The works should be arranged in two lines; the outer line—the object of which is to prevent the hostile fleet from penetrating by force into the harbour—should be armed with guns of large calibre and of long range so as to keep hostile vessels at a distance. Heavy mortars will find their place in the second line.

The part played by coast artillery does not depend solely on the targets presented to it, but also on the effect which is produced by the projectiles which are selected and on their destructive power. It was proved at Port Arthur—and at Tsushima – that vessels are put out of action and even sunk, not merely by projectiles which pierce the armoured belt, but also by other projectiles which strike the vessel above the water line; that is to say in general by those projectiles which destroy or damage the weakly protected or unprotected portions of the superstructure. The essential requirements of this superstructure are that it should be able to resist water which may penetrate by holes pierced above the water line, and that it should not readily catch fire. We shall see further on, that the most effective means of reducing battleships is by setting them on fire.

Before the Russo-Japanese War there were two opposing schools of thought regarding the methods that should be adopted in order to destroy armoured vessels. The one, basing its opinions on the experiments carried out against the *Belleisle*, maintained that the armoured belt must be pierced, at or below the water line, by the aid of an armour-piercing shell provided with a small bursting charge; the other held that the

Digitized by Google

greatest effect would be obtained by the use of long shell provided with large bursting charges, which would be directed against the superstructure, and which would not be intended to pierce the belt or damage the engines and boilers. The English adhered to the opinions of the first of these schools, whilst the French and Russians concurred with the second. Nevertheless during the war the Russians used armour-piercing shell with small guncotton bursting charges exploded by percussion fuzes, the action of which was so much retarded and so insensitive that frequently they failed to burst even after passing through light armour.

On the other hand, the Japanese vessels were provided with high-explosive shell of large capacity, the weight of the charge amounting to 9·5 per cent. of the total weight of the shell, and with very sensitive fuzes, which were not retarded.

The experiments carried out against the *Belleisle* in 1900 led all nations —except Russia—to adopt lyddite or mélinite shell.

The lessons to be drawn from the battle of the 28th July, 1904, off Port Arthur are that the injuries caused by shell, the fuzes of which are not retarded, are the most dangerous, because :—(1), It is very difficult to close the holes made by them in the sides of a vessel, as these holes are of large dimensions and their edges are turned in towards the inside of the vessel. Thus the water enters in very large quantities when the ship rolls and when the hole is situated a little above the water line; (2), the damage caused to the interior of the structure is necessarily greater, because not only the fragments of the projectile, but also pieces of the side of the ship—sometimes 10 square feet in area—were violently projected into the interior with their rivets, bolts, etc. It appeared that only a very small part of the force of the explosion was expended along the side of the hull, by far the greater portion taking effect on the interior. Another lesson is that it is necessary to employ projectiles which injure the motive power of the vessel, *e.g.*, projectiles which riddle the funnels, rather than shell, which after having pierced the belt can damage the interior of the vessel.

The Battle of Tsushima demonstrated in an even more striking manner the superiority of high-explosive to armour-piercing shell. The *Oslabia*, *Souvarow*, *Borodino*, and *Alexander III.* were put out of action and sunk, because the high-explosive shell destroyed everything above the water line. The torpedo boats did not give the *coup de grâce* until after the above-mentioned vessels had been destroyed by gun fire. Eye-witnesses declare that at Tsushima the Russian battleships were wrapped in a dense shroud of flame and smoke, caused by the fires which had broken out on board them.

The Battle of Tsushima has proved anew that the active power of a vessel, or of a fleet, as well as that of every coast battery, depends not on its armour, parapets, or traverses, but solely on the power of its fire, which is dependent not merely on the calibre, range, and rapidity of fire of the guns, but also on the destructive force of its shell, measured not only by their momentum, but by the explosive energy of their bursting charges.

It was not the superior speed of the Japanese ships, nor their armoured protection, nor the excessive loading of the Russian vessels, nor even the

Digitized by Google

superiority of the Japanese in *personnel*, *matériel* and number of guns of medium calibre, which decided the naval battles in Asia, but solely the torpedo shell with large bursting charges, which was opposed only by armour-piercing shell, and shell with small bursting charges.

The bombardment of the harbour of Port Arthur showed that the efficacy of naval as well as of coast artillery does not depend on its power of discharging the maximum weight of metal in a given time, but on its being able to discharge projectiles provided with very large bursting charges of very powerful explosives.

The following important conclusions regarding the armament of coast defences may be deduced from the events of the war:—(1), The principal projectile should be the high-explosive shell; (2), the proportion of common shell need not be great; (3), armour-piercing shell should be done away with; (4), the armament may be divided into three classes, heavy, medium, and light. Mortars may be employed in the second line; (5), all long-range guns should be provided with telescopic sights; (6), medium and light guns should be quick-firers.

History shows us that the majority of maritime fortresses have fallen before an attack from the land side. If the neighbouring bays and harbours had been commanded by high-angle fire batteries—established under cover from the observation of the enemy—the hostile fleet would have been unable to have entered them, and the contest between this fleet and the batteries would have offered no prospect of success to the former. It is not sufficient to close these bays by means of mines, as was proved at Dalny. It is absolutely indispensable to construct batteries in order to deny them to the enemy, and the best armament for them consists of mortars or howitzers having an all-round arc of fire, supplemented by gun batteries where the ground is suitable. The 28-cm. (11″) howitzer is a suitable weapon, and may be installed at a distance of 2½ to 5 miles from the bay or harbour that is to be defended. It will suffice to shelter these howitzers in stores or sheds close to the place where they will be required. The sheds should be connected with the batteries by lines of rail, so that the pieces may be mounted very rapidly. All the batteries of the fortress should be connected in the same manner. The trucks used on these lines should have a carrying capacity of 30 tons.

Maritime fortresses must be protected on the land side by chains of detached forts, provided with bombproofs capable of keeping out the shells of the 11″ howitzer. They must be armed with howitzers firing high-explosive shell and shrapnel, and should be sited—not on commanding points—but in places where they are completely screened from hostile view.

All the harbours close to a maritime fortress should be defended by at least one battery, which may be armed either with obsolete guns or with guns taken from the ships of war. Such batteries will often prevent any attempt at a landing, and no landing is possible unless a harbour is available. The guns and ammunition may, if necessary, be stored in the fortress itself, and the batteries may be constructed by the engineers during their annual periods of training.

The internal communications of a coast fortress are of primary

Digitized by Google

importance, and must include a complete system of telephones, telegraphs, and railways, connecting every portion of the defence. Wireless telegraphy should be installed.

Preparations must be made in peace time for an active defence. The ill-success of the Russians both at Sebastopol and Port Arthur was due chiefly to the passive character of the defence of those places.

'M.'

## JOURNAL DES SCIENCES MILITAIRES.

*December 15th*, 1908.

The discussion on the reorganization of the infantry and artillery is continued. Opinions are very diverse, and a great deal of the matter is either repetition or of little interest. The following are some of the opinions expressed:—

The 1905 law diminishes the peace strength of the army by 45,000. A battalion over 1,000 strong is unmanageable. If corporals are done away with it will be necessary to endow the senior soldier in each squad with authority to keep order in the room, as the sergeants who are in command of squads will not live in the barrack rooms. An officer should be attached to the colonel to look after official correspondence.

The most difficult question to solve seems to be how the frontier can be effectively guarded during the critical period from September to January, *i.e.*, while the recruits are not fit to take their places in the ranks. Another difficulty is how to officer the reserves when called up.

Cyclist battalions are recommended.

Turning to the artillery, it is said to be impossible for one man to command 6-gun batteries under fire, and if it is necessary to have 6 guns therefore they should be subdivided into 3-gun sections. The proposal to cut down the cavalry so as to increase the number of horses available for the artillery, is met by suggesting the extensive adoption of motor transport for artillery parks. Another correspondent summarizes the arguments in favour of 4-gun batteries, as (i.) after seven years' experience the artillery have become well acquainted with them, (ii.) they are quite large enough for one man to look after.

The German 1908 War Budget is subjected to detailed examination. An experimental company is to be added to the balloon battalion at Berlin. Civilian workmen are displacing military in the storehouses, setting free 500 men for field service. £40,000 is to be spent on motor wagons. A debate was held in the Reichstag on the advisability of reducing the cavalry service to two years. Arguments in favour of it were that cavalry and horse artillery were well enough trained in one year, otherwise the one-year volunteers ought to be entirely done away with: the critical state of the French cavalry was due to not taking measures to ensure the re-engagement of enough men. The answer was that the presence of men in their third year was essential for training horses, patrolling, and providing enough N.C.O.'s.

Digitized by Google

A further instalment of "Souvenirs of Casablanca" gives an account of a cavalry fight on February 18th, 1908.

*January 1st*, 1909.

The discussion on infantry and artillery organization is continued, and the "Combat of Rfakha" in Morocco is concluded by the account of the pursuit and bivouac. The author of the "Decisive Attack" sums up his conclusions as follows:—(1). No attack is possible until such a superiority of fire has been gained that the hostile artillery and infantry are incapable of acting on the chosen zone of attack. (2). The most favourable zone of attack is that in which, owing to the configuration of the ground, the assailant can bring into action more guns and rifles than the defender. (3). Perfect combination between infantry and artillery is necessary. (4). The attack should be in three lines—(*a*), a line of skirmishers and supports to maintain fire superiority and to deliver the assault; (*b*), a line of columns in closer formation, so as to relieve the first line on the captured position, to follow up the success, and to support the threatened flank against hostile counter-attacks; (*c*), a general reserve. (5). The bulk of the cavalry should maintain close connection with the threatened flank, act against counter-attacks by enfilade fire, and lose no chance of transforming into a rout any wavering on the part of the enemy.

A final article on the infantry machine gun considers the tactics which it should employ. Machine guns can never take the place of the living element and intelligence inherent in infantry, and the flat trajectory prevents their being fired over the heads of their own men, as can be done when using artillery. Their only chance of reaching the firing line in attack is due to the slowness of its movements. In the attack machine guns will be used to strengthen important points which have already been seized by the infantry, and which may be used as rallying points in case of a repulse. When the attack is successful, they will hurry forward to the conquered position to join in the fire which will be brought to bear on the flying enemy.

On the defensive, with the ranges measured, machine guns will be most effective. They will be most useful on false fronts in advance of the true line, and on the real front will be used either to search the openings of the roads along which the enemy is advancing or to occupy the salients of the position, and to sweep dead ground. But they should be kept under cover from fire till wanted, so as to prevent their premature destruction by the hostile artillery. They add considerably to powers of resistance of the advanced guard, and will have to join in the sacrifices made by cavalry and artillery when acting as rear guard to beaten infantry. In night fighting machine guns—laid by day on important points—will be far more effective than random rifle fire would be.

In attacking a position defended by machine guns artillery must endeavour to knock them out, or in any case to raise such a cloud of dust and smoke before them as to render aimed fire impossible. The infantry may then advance in safety provided the space just in front of the machine gun is left empty in case of random fire being opened.

In the *Military Month* is an account of a new model of the present

Digitized by Google

field gun. The weight is reduced from 4,000 lbs. to 3,400 lbs. The force of recoil opens the breech and ejects the empty cartridge case, and the action of loading shuts the breech. Five men can work it, in place of six, and the shield is larger.

*January 15th*, 1909.

An article on the intellectual instruction of infantry officers opens by emphasizing the necessity for careful preparation for war. The German regulation that "The main strength of an army lies in its constant preparation" is quoted. It is most desirable to have unity of doctrine, as in the case of the Germans at Spicheren, where three generals followed each other in the command, and yet all pursued the same course. At Sedan, on the other hand, the three French commanders held widely differing ideas.

The commander must see clearly the end in view when he undertakes any operation, and direct all his strength to attaining it. The object of Mistchenko's famous cavalry raid on Yinkow was to destroy the Japanese magazines. Why then did he drag an enormous convoy with him and waste time in attacking villages whose capture was unnecessary?

In issuing orders, no more than the objects to be attained should be given. It is the duty of the subordinates to find the means.

To only half obey an order is a worse offence than to disobey, as it makes a commander imagine his orders are being carried out. The conduct of de Failly in 1870 is instanced. Owing to his supineness in carrying out perfectly clear orders he first of all caused the defeat at Froeschwiller, and then was surprised and had his corps practically put out of action at Beaumont.

Initiative is particularly necessary with modern extensions. It does not suddenly spring into existence on the battlefield, but must be cultivated in peace time. It becomes independence when a subordinate acts for his own advantage and not for that of the whole, and such acts should be put down. Indiscipline is voluntary, and in war time is a crime. Solidarity is the fourth military virtue, which sets in action all the others. It consists in an unselfish devotion to attain the common end and was strongly marked both in the Germans in 1870, and also in the Japanese; in Napoleon's armies it was rather weak. Dragomiroff sums it up in the remark "Perish, but save your brother."

A company of cyclists was employed during the divisional manœuvres of the 20th Corps in 1907. Details of three days' work are given. The chief conclusion arrived at is that, without cavalry, cyclists are practically useless. They are poor scouts as most of their attention is occupied by their machines, especially when riding against a head wind or on a bad road. The numbers of a cyclist company are so small for a detached force as to make any detachment—even for security—very serious. Flank protection is difficult. If a detachment is sent out to follow a parallel road a mile or two off it seriously weakens the main body; and if an infantry flank guard is used, the advantage of pace is lost. On the whole cyclists are quite useless as cavalry substitutes; without cavalry they cannot avoid a dangerous dispersion. Their use seems to be as supports

Digitized by Google

for cavalry, thus enabling the latter to remain mounted and seize opportunities which would be lost if some of the squadrons were in the firing line.

A Russian fieldworks manual has just been issued. Infantry are to be capable of simple works and of working telephones. A certain number of infantry officers and men are attached to sapper companies in summer for instruction. Great attention is paid to the concealment of trenches.

The manual is in three parts, for soldiers, N.C.O.'s, and officers. Only the first two parts have so far appeared. The part for the men is free of all figures and superfluous details; simple diagrams show the common forms of trench for fire when standing, kneeling, and lying down. Numerous traverses are necessary to protect against H.E. shell fire and enfilade; bombproofs, covered communication trenches, and shelter for reserves are also mentioned. Trenches behind the firing line may be necessary for use while a bombardment is taking place.

The N.C.O.'s manual gives more detailed descriptions of the trenches, and draws attention to siting of trenches so to avoid dead ground. Very low parapets not exceeding 18″ are shown. A berm half-way up the interior slope of trenches is provided, so as to facilitate the delivery of counter-attacks. Head cover is suggested. Obstacles are to be 50 to 75 paces in front of the trenches.

Redoubts of higher profile are to be established on important points. Protected look-outs, bombproofs, and machine-gun emplacements are to be prepared. Numerous traverses are required inside to localize the effects of shell bursts.

Latrines, inclined entrances for supports, and special shelters for reserves are to be provided.

H. L. Woodhouse.

---

## Le Bulletin.

*November 30th, 1908.*

International Law.—*Russo-Japanese War (continued).—Siege of Port Arthur (continued).*—An interesting note on suspension of hostilities for the removal of dead. It appears that up to the beginning of December, 1904, no armistice had been sought or granted for the purpose of removing the dead in the neighbourhood of the permanent forts. Their number must have been considerable, as Colonel de Grandprey says that the fourth general assault on November 26th cost the Japanese 12,000 men. The first advances were made by the Russians in the counterscarp galleries of N. Kikouan, which had been subjected to four assaults lasting six hours. Arrangements were made, apparently without consulting superior authority, for a suspension of hostilities on December 2nd at this fort. The Japanese dead were brought out by the Russians and placed about 15 yards in advance of the trenches. The relations of the two sides during this scene are said to have been most cordial, although a few miles to the west a furious battle was raging for the possession of

Digitized by Google

203-Mètre Hill, captured three days later. Afterwards the matter of concluding local armistices was left to divisional commanders.

The text of the capitulation of Port Arthur is given; the most noteworthy provisions were those including Government officials in the number of prisoners of war (due to the semi-military status of Russian officials), and giving permission to the officers of the garrison to wear their swords; this was apparently incorrectly rendered into English, and should have read "retain" instead of "wear." Subsequent confusion was caused by the Russians maintaining their right to wear their swords in Japan.

FIELD SERVICE REGULATIONS, GERMAN ARMY.—*Reconnaissance.*—There is little of note under this heading. The regulations seem to favour the use of infantry officers' patrols—for artillery officers' patrols are the rule.

*December 15th*, 1908.

INTERNATIONAL LAW.—*Russo-Japanese War (continued).*—Further remarks on the siege and capitulation of Port Arthur deal with the question of the civil population (non-combatant); at the time of the capitulation there were 6,000 Russian inhabitants, and 55 of other nationalities in the town. Their property was respected, and they were free to leave the fortress. As however the majority of them desired to go, the arrangements made to despatch them by junk from Pigeon Bay at their own expense were found impracticable. The Japanese then undertook to provide them with free railway and steamboat passage, at first from Chang-Ling-tse *viâ* Dalny to Cheefoo, and later on from Port Arthur itself. From January 20th an emigrant train left Port Arthur daily for Dalny and Cheefoo. When all arrangements had been made for placing the fortress in a state of defence against the Baltic Fleet, it was decided to send away all remaining foreigners.

The article concludes with a note on martial law. This was never generally proclaimed by the Japanese, partly to avoid giving offence to a neutral power, partly because of the difficulties in applying it to various cases. All illegal acts on the part of the inhabitants were dealt with on their merits. However much there is to be said for this decision, it cannot be denied that the proclamation of martial law has a moral effect in itself which tends to prevent the occurrence of such acts. A list of the principal offences dealt with include tampering with payment vouchers, making trenches, and trafficking in opium. As regards courts-martial, it is noted that the fundamental difference is that in the field the accused is presumed guilty, and the burden of refutation rests on him.

*December 31st*, 1908.

GERMAN FIELD SERVICE REGULATIONS.—Under "Protection" it is laid down that outposts in contact with the enemy are responsible that this contact is not lost—even if the enemy alters his position by retiring by night for instance. This seems to be demanding a good deal from infantry outposts. On the march outposts are furnished on halting, without further orders, by the advanced or rear guard.

Digitized by Google

FOREIGN MILITARY INTELLIGENCE.—It is interesting to compare German recruiting statistics, 1907, with those for France given in *Bulletin* of November 30th :—

| | | | |
|---|---|---|---|
| Unfit for military service ... | Germany ... ... ... | 2·85 per cent. | |
| | France ... ... ... | 19 ,, | |
| | | No. | Per cent. |
| Unable to read or write ... | Germany ... ... ... | 39 | or 0·025 |
| | (Prussian cont. of 151,900) | | |
| | France .. ... ... | 11,062 | or 3·53 |

*France.*—Infantry and cavalry regiments are to be at once supplied with machine guns (four per regiment).

'E.R.'

---

REVUE DU GÉNIE MILITAIRE.

*December*, 1908.

THE BALLOON AT CASABLANCA.—A balloon section for service in Morocco was formed in August, 1907, and arrived at Casablanca on the 7th September. At the time the French had no reliable information as to the position of the Moorish forces in the neighbourhood. On the 10th September the observers in the balloon discovered a Moorish camp of 640 tents at Taddert, some 10 kilomètres from Casablanca. They were also able to report that there were no other camps within a radius of 15 kilomètres. Acting on this information, the French moved out on the 11th September and destroyed the Moorish camp. After this ascents were only made at night, so as to avoid warning the enemy. On the 15th September the balloon discovered a camp of 700 tents at Sidi-Brahim, and on the 21st September the French destroyed this camp also. The ascents were made with great difficulty owing to the heavy wind. The balloon was out of action from the 14th October to the 8th November, as all the gas had been used and the fresh supply had been delayed by floods in the south of France. On the 11th November a new camp of 300 large tents was discovered at Sidi-Aissa, at a distance of 27 kilomètres, and it was ascertained that this was the only camp within a radius of 35 kilomètres. Night observations were now useless, as the distances were too great to observe the Moors' camp fires. About this time a number of ascents were made to try to locate Abdul Aziz's last army—under the command of Bagdadi—which was expected to enter the zone of operations, but it was defeated and dispersed some 50 kilomètres from Casablanca. The section also provided a signal balloon which was sent up as required. On the march the signal balloon was kept fully inflated, the rope being made fast to a mule. In January, 1908, the balloon supplied the first information that the transport *Nive* had run ashore some 9 kilomètres from Casablanca. The balloon section attempted to send a line on board by means of kites, but without success. At a later date the balloon section accompanied several mobile columns. The conditions

Digitized by Google

under which it was compelled to work were disadvantageous, as the columns never halted long enough to permit of proper observations being taken. Some officers objected to the presence of the balloon, because, they complained, it warned the Moors of the approach of the column. But it is doubtful whether the appearance of the balloon gave them any information which they did not already possess.

AERIAL PHOTOGRAPHY.—A description of an apparatus used for taking photographs from a kite. The camera can be turned to any required vertical or horizontal angle without bringing the kite down. This is effected by electrical apparatus. A series of eight exposures can be made. The plates are placed one behind another at the back of the camera, and after each exposure is made the exposed plate falls face downwards into the bottom of the camera.

J. E. E. CRASTER.

---

## REVUE MILITAIRE DES ARMÉES ÉTRANGÈRES.

*December*, 1908.

The article on the military use of skis is continued.

In Germany the ski is used by the 18 rifle battalions and by certain infantry regiments garrisoned in mountainous regions. The number of trained men per rifle battalion varies; only 12 pairs of skis are provided per battalion. The officers and N.C.O.'s—who are expected to teach their men—are recommended to buy *Der Skilauf* (a book on ski-ing), as no military textbook on the subject is published. In the Black Forest and the Vosges, the troops are allowed to take part in the competitions organized by the "Ski-Club Schwarzenwald" and the "Ski-Club Vosgien," which include reconnaissance and long-distance races.

In Austria about 20 to 50 men per brigade or division are trained by a lieutenant. In 1908 a special ski course for officers was instituted with the object of training good instructors. The course lasted five weeks, the last six days being devoted to a march in high altitudes. The best ski-runner in Austria—M. Zdarsky—was attached to the director of the course, as technical adviser.

Military competitions are organized regimentally for soldiers, and officers and N.C.O.'s are allowed to take part in the annual competition of the "Touristen-Club." In Italy each Alpine company must have three trained ski-runners (*sciatori*), who are specially trained (1), in scouting; (2), as orderlies; (3), in the occupation of advanced positions; (4), in protective duties. Hitherto the skis have been of Swiss make, but they are now being made regimentally. A cup was founded in 1907 to be competed for annually. The winners of 1908 travelled over the 10 kilomètres, with a difference in level of 700 mètres, in 1 hour 45 minutes. They wore uniform and were in marching order.

Digitized by Google

In Switzerland the training is very complete, and annual courses are organized which last from 8 to 10 days. The course is partly tactical and partly technical. In 1907—1908, 316 officers and N.C.O.'s were trained, and a grant of 20,000 francs was made for this purpose. All mountain troops would, in case of mobilization, be provided with skis; actually however only four battalions are equipped with 20 pairs of skis, 20 pairs of rackets, and 20 pairs of "snow planks" each.

An annual competition is held at Engelberg. The competitors are divided in two classes—(1), 9 officers; (2), 14 N.C.O.'s and men. The course is 4 kilomètres long, with a difference in level of 300 mètres. During the race the officers have to fire six rounds at a kneeling figure 40 mètres away, and the N.C.O.'s and men eight rounds at standing figure 200 mètres distant. The best times for 1908 were:—Officers, 46 minutes; N.C.O.'s, 44 minutes.

In the United States and Japan there are no regular exercises, but in the former case practice was carried out by the cavalry at Yellowstone National Park in 1907, and, in the latter, in the Island of Yezo during the winter 1904—1905.

Details of the skis and of the various courses are appended to the article.

A mobile search-light detachment in Holland consists of one wagon for the projector and one for the dynamo and motor. The motor is a petrol 9—12-B.H.P. engine and carries petrol for 10 hours. It can drive the back wheels of the wagon. The projector is 26 million c.p. strong and requires 45 volts. The light is ready for use 15 minutes after taking up a position.

The subject of military ballooning in Germany is continued from the October number.

German dirigible balloons can be divided in three classes.

(1). The non-rigid (*umstarr*) or Parseval system, in which the shape of the balloon is maintained by the internal gas pressure.

(2). The semi-rigid (*halb-starr*) or Gross system, in which the gas bag is fixed to a light metal platform, from which the car is suspended.

(3). The rigid (*starr*) or Zeppelin system, in which the gas bag is stretched over a metal skeleton shape, and which is filled with several smaller gas bags.

These systems have their various advantages and disadvantages. The first is the simplest to transport as the balloon is easily emptied and carried in a small number of carts. It can land anywhere and dead weight is reduced for a minimum.

The rigidity of the Zeppelin type greatly facilitates its steering, but increases its dead weight and the difficulty of transporting the balloon when empty. Moreover if assailed by a tempest whilst on the ground the balloon rapidly becomes unmanageable. It also can only land on water. The Gross system can land anywhere, and although less easily

Digitized by Google

portable than the Parseval type it has none of the inherent defects of the Zeppelin.

The Parseval balloon was first thought of in 1901 by Major von Parseval, and was intended to be a dirigible balloon for use in the field, capable of attaining a height of 2,000 mètres, and of carrying three persons for 10 hours. The first successful trial took place in 1906. The balloon had attained its object. It was bought in October, 1906, for £6,500, by the "Motorluftschiff-Studien Gesellshaft," which perfected it.

The peculiarities of the system are :—

(1). The presence inside the main gas bag of two smaller ones, which are filled with air as required, and thus serve to elevate, depress, or keep the balloon level.
(2). The suspension of the car, which allows of its sides always remaining vertical.
(3). The use of a non-rigid propeller, which only becomes taut when the propeller is revolving.

The following are the data of the second Parseval balloon :—

(1). Lifting force = 3,800 kilogrammes.
(2). Capacity of air bags = 1,200 cubic mètres.
(3). Weight of gas bag = 750 kilogrammes.
(4). Weight of motor, propeller, etc. = 1,300 kilogrammes.
(5). Weight of water, benzine, and oil = 400 kilogrammes.
(6). Weight of ropes, guide ropes, and odd fittings = 400 kilogrammes.

Thus 800 kilogrammes remain for passengers and ballast. All the journeys were made with five to six passengers. After a final trial run on the 28th of November, 1908, the Parseval balloon was bought by the military authorities.

In 1905, owing largely to the success of the French dirigible, "Lebaudy II.," the German Government resolved to undertake privately the construction of an airship. Major Gross, Commandant of the "Luftschiffer-Batallion," was charged with its construction.

The history of the first flights of this type and the German arguments against the accusation of having copied the "Lebaudy" are given at length in the article. It is finally stated, as a result of experience, that wireless messages can be received, but not sent from a dirigible airship.—(*To be continued*).

A. H. SCOTT.

Digitized by Google

# THE HELLIWELL
# PATENT "PERFECTION" GLAZING.

## ADVANTAGES.

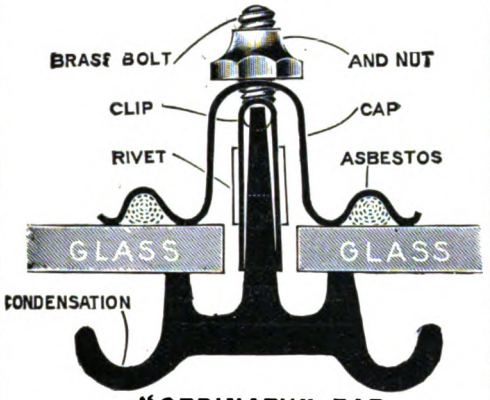
No Putty.
No Paint.

Guaranteed Water-tight and Dust Proof.

Easily Repaired.

Planks laid in Safety across Caps.

Steel Bars galvanized; and also entirely covered with Lead to prevent Corrosion.




"ORDINARY" BAR.
"Ordinary" Section.
BARS of different strengths, to carry up to 12ft. without Purlin.
CAPS in either Copper, Zinc, or Lead.

## EXTENSIVELY USED BY

H.M. Government, for Barracks, Dock Sheds, Post Offices, Stores, etc.

All the leading Railway Companies.

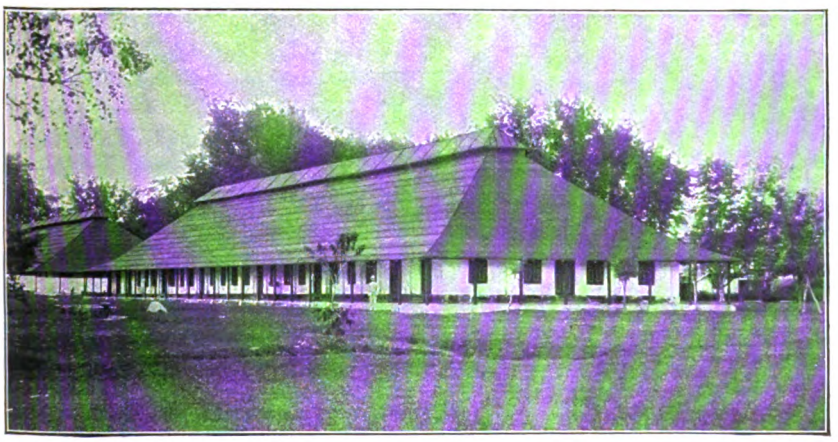
Municipal Authorities, for Markets, Baths, Libraries, Art Galleries, Schools, etc.

Also for every kind of Glass Roofing.

Head Office and Works: **HELLIWELL & CO., Ltd.,**
London Office: 11, Victoria Street, Westminster, S.W. **BRIGHOUSE, YORKS.**

# RUBEROID!
# ROOFING!

A High Grade Permanent Roofing Material in general use for all classes of Buildings. Its light weight as compared with other roof coverings makes it particularly useful where long transport of building materials is necessary.



Quarters of the Malay States Guides, Sepoy Lines, Penang, covered with Ruberoid.

Full particulars of cost and shipping weights gladly supplied. Our Illustrated Catalogue, No. 39, and samples sent post free on application.

**THE RUBEROID COMPANY, Limited, 81 & 83, Knightrider St., LONDON, E.C.**


Digitized by Google

SPECIFY

# INDENTED STEEL BARS

FOR YOUR

## *Reinforced Concrete Work,*

And you will obtain HIGHEST POSSIBLE STANDARD OF EFFICIENCY, combined with GREATEST POSSIBLE ECONOMY.

**NO ROYALTIES TO PAY.**

Head Office:—

**QUEEN ANNE'S CHAMBERS, LONDON, S.W.**

Branches all over the United Kingdom.

TELEGRAMS:—"PATINBAR, LONDON."

# BENJAMIN EDGINGTON'S

# Tents & Camp Equipment

FOR ALL CLIMATES.

**TENTS.**
**CAMP FURNITURE.**
**CANTEENS.**

**Air and Water-tight Uniform Trunks.**

**DECK CHAIRS.**

**Clothing and Personal Outfit.**

**Double-Roof Ridge Tent,** as supplied for all the principal Surveys, Boundary Commissions, Railways, etc., in East and West Africa, and other parts of the World.

WRITE FOR TRAVELLERS' CATALOGUE.

**BENJAMIN EDGINGTON** (S. W. Silver & Co., and Benjamin Edgington, Ltd.),

**2, Duke Street, London Bridge, London, S.E.**

Telegrams: "BENJAMIN EDGINGTON, LONDON."

Digitized by Google

# HAWKES & CO., LTD.,

TAILORS AND MILITARY OUTFITTERS, CAP AND ACCOUTREMENT MANUFACTURERS,

14, PICCADILLY, LONDON.

*Patronized by many Officers of the Royal Engineers.*


## PROFESSIONAL PAPERS OF THE CORPS OF ROYAL ENGINEERS.

FOURTH SERIES.—VOL. I., 1905.

| | | | |
|---|---|---|---|
| PAPER | I. | **Simple Tunnel Work on the Mari-Attock Railway, Panjab,** by Capt. H. E. C. Cowie, D.S.O., R.E. | 1s. |
| ,, | II. | **Long Span Bridges,** by Max am Ende, M. INST. C.E. | 1s. 6d. |
| ,, | III. | **Recent Works in the N.W. Frontier Province, India** (Fortified Posts, Roads, Bridges, Civil Buildings), by Bt.-Col. G. K. Scott-Moncrieff, C.I.E., R.E. | 3s. 6d. |
| ,, | IV. | **Armoured Trains,** by Capt. H. O. Mance, D.S.O., R.E. | 3s. 6d. |
| ,, | V. | **Reinforced Concrete,** by Lt.-Col. J. Winn, late R.E. | 2s. 6d. |
| ,, | VI. | **Fortress Warfare,** by Capt. Moritz Ritter von Brunner. 9th edition of the work originally written by Field Marshal von Brunner. Translated by Capt. C. Otley Place, D.S.O., R.E. | 3s. 6d. |
| ,, | VII. | **Fortresses and Military Engineering in Recent Literature.** No. 43 of the "Mitteilungen des Ingenieur-Komitees." Translated by Capt. F. A. Buzzard, R.F.A. | 5s. |

VOL. II., 1908.

| | | | |
|---|---|---|---|
| PAPER | I. | **The Theory of Arched Masonry Dams,** by Capt. A. ff. Garrett, R.E. | 1s. 6d. |
| ,, | II. | **Report on Mechanical Road Transport for India,** by Capt. E. N. Manley, R.E. | 2s. |

The price of separate Papers as above, in paper wrappers, 1s net.
They may be obtained from Messrs. W. & J. MACKAY & Co., LTD., Chatham, or from any Bookseller.

Digitized by Google

## "ANCHOR" LINE.

## Passenger and Cargo Services.

LIVERPOOL to BOMBAY & KARACHI (*viâ* Bombay). Fortnightly.

LIVERPOOL to CALCUTTA. Fortnightly.

**All Vessels call at Egyptian Ports.**

Large New Steamers. Splendid Accommodation for Passengers. Electric Light and Fans. Excellent Cuisine. Every Comfort.

Moderate Fares, both Single and Return

Apply—"ANCHOR" LINE (Henderson Brothers), Ltd., Liverpool, London, Glasgow, &c.

## Nippon Yusen Kaisha.

Japan direct from London in 47 days, calling at COLOMBO, SINGAPORE and HONG KONG, by fast steamers fortnightly.

WAKASA MARU, 6,265 tons, March 6.

**To Japan, £54, 1st Class; £37 10s., 2nd Class; to other Ports at equally moderate rates.**

HIRANO MARU, *viâ* Marseilles, 8,520 tons, March 13. Fares on application.

ROUND THE WORLD, £107.

For Fares, etc., apply at—

**4, LLOYD'S AVENUE,**
**LONDON, E.C.**

## Institution SILLIG,

**BELLERIVE,**
**VEVEY, SWITZERLAND.**

**ESTABLISHED IN 1836.**

A HIGH-CLASS SCHOOL for the education of Boys in Classical, Scientific, Military, and Commercial Subjects, and for General, Moral, Mental, and Physical Development.

PRINCIPAL:

**MAX SILLIG—DE VALLIÈRE.**

## THE ARMY SCHOOL,

**Near MAIDENHEAD**

(Approved by the Army Council).

**Head Master:**

**E. G. A. Beckwith, M.A. Oxon.**

*(Late Exhibitioner of Winchester and Magdalen College).*

"A small public school in which boys from the age of twelve are prepared for the Army. The school buildings include a chapel, large dining hall, swimming bath, gymnasium, chemical and physical laboratories, besides 30 acres of playing ground."

SUCCESSES, 1907—1908.

Woolwich—One.
Sandhurst—Thirteen.
Qualifying Certificates—Sixteen.
Leaving Certificate—Five (Three Woolwich).

For FEES, etc. (reduced for Sons of Officers), apply to the Head Master.

## NAVIGAZIONE GENERALE ITALIANA.

The fine steamers "R. RUBATTINO" and "D. BALDUINO" sail alternately from

GENOA TO BOMBAY on the 18th of each month, at 2 a.m.

FARES: 1st Class, £40 & £33; 2nd Class, £27 10s.; 3rd Class, £11.

GENOA TO ALEXANDRIA every Saturday, at 9 p.m.

NAPLES TO PALERMO every Evening, at 7.25 p.m.

For Tickets and Berths apply to the Co.'s Agents—

**ALFRED LAMING & CO.,**
**8, Leadenhall Street, E.C.**

## NOTES FOR THE TACTICAL FITNESS EXAMINATION,

With Sample Schemes and Solutions,

By Major A. T. MOORE, R.E.

PRICE
TWO SHILLINGS AND SIXPENCE,
Post 3d. Extra.

Obtainable from the Secretary, R.E. Institute, Chatham, and Rees, Limited, 119, Pall Mall, S.W.

## G. E. CARRINGTON,

For many years Master Tailor, Royal Engineers,

## *TAILOR & MILITARY OUTFITTER,*

53, HIGH STREET,
OLD BROMPTON, KENT,

Attends CARLTON HOUSE, REGENT STREET, near Waterloo Place, S.W., every TUESDAY and THURSDAY, from 11 a.m. to 6 p.m., and at any other time by appointment.


Digitized by Google

# R.E. INSTITUTE

# New Publications.

---

MANUAL OF

## Road Construction & Maintenance

**Compiled at the S.M.E., by MAJOR PAUL, R.E.**

**FULLY ILLUSTRATED.**

Price **4s. 6d.**, Post Free. Members of the R.E. Institute, **3s.**

---

**ABBREVIATED NOTES**

**ON**

## Military Engineering

CONTENTS:

**Ropes, Spars, Tackles, Strength of Materials, Bridging, Field Defences, Camping Arrangements, Demolitions, Roads.**

**POCKET BOOK SIZE. INTERLEAVED.**

Price **6d.**, Post Free.

---

## Modern Sewage Disposal,

BY

**Capt. and Hon. Major G. B. WILLIAMS, R.E. (T.).**

Reprinted from the R.E. JOURNAL. Price **6d.**, Post Free.


Digitized by Google

The McKenzie, Holland, &
Westinghouse Power Signal Co., Ltd.

# POWER SIGNALLING

Electro-pneumatic,
all-electric, and
automatic signalling.

Address:
58, VICTORIA STREET, LONDON, S.W.
Telegrams: "Powersig, London." Telephone: 890 Westminster.

PORTLAND CEMENT.
# CONCRETE FIRE-PROOF SLABS.

For Internal and External Walls.
As cheap as any other, with the following advantages:—
ECONOMY OF SPACE, GOOD KEY FOR PLASTER TILING, ETC., NO PLUGGING, AND SETTING COAT OF PLASTER ONLY REQUIRED.

*For Particulars and Prices apply to:*
THE ACTON CONCRETE PATENT PARTITION CO., 1909, Ltd.,
Telegrams: "KONKREET, LONDON."
Telephone: 6294 AVENUE.
63, CORNHILL, LONDON, E.C.

## THE OFFICE FOR OFFICERS.

**LIFE ASSURANCE.** Specially designed for the Services.
**CONVENIENTLY PAID FOR** by Bankers' Orders (Monthly Premiums if desired).
**NO MEDICAL EXAMINATION** up to £500, in ordinary circumstances.
**LOANS AND SURRENDER VALUES.** Liberal and easy conditions.
**EXCEPTIONALLY GOOD TERMS** for War Risks and Foreign Residence.

Call or write for new Service Prospectus.

Royal Exchange Assurance, (Incorporated 1720.)
West End Office: 44, PALL MALL, S.W.

Digitized by Google

# THE ROYAL ENGINEERS JOURNAL.

Vol. IX. No. 5. MAY, 1909.

## CONTENTS.


| | | Page. |
|---|---|---|
| 1. | **Electric Traction on Railways.** By Philip Dawson, Esq., M. Inst. C.E., M.I. Mech. E., M.I.E.E., Consulting Electrical Engineer to the L.B. & S.C.R. (*With Photos*) ... ... ... ... ... ... | 329 |
| 2. | **Penetration of the Rifle Bullet into Snow.** By Major J. C. Matheson, R.E. ... | 349 |
| 3. | **French and English Methods in Field Telegraphy.** By Major E. G. Godfrey-Faussett, R.E. ... ... ... ... ... .. ... | 351 |
| 4. | **A Proposed Tension Bridge.** By Capt. E. N. Mozley, R.E. ... ... | 355 |
| 5. | **Territorials of the Roman Imperial Army, 1st Century, A.D.** By Col. O. E. Ruck, late R.E. ... ... ... ... ... ... | 363 |
| 6. | **Swallow Holes in Chalk.** By Col. W. Pitt, late R.E. (*With Plate*)... ... | 365 |
| 7. | **The R.E. Headquarter Mess** (*continued*). By Lt.-Col. B. R. Ward, R.E. ... | 371 |
| 8. | **Memoir:**—The late Colonel John Roberts Hogg, R.E. By 'A.T.S.' ... ... | 375 |
| 9. | **Transcripts:**—Field Kitchens in the German Army. By Col. E. Hartmann. (*With Photos*) ... ... ... ... ... | 377 |
| | Mirrors for Search-Light Projectors. (Translated from the *Rivista Maritima* by Major E. G. Godfrey-Faussett, R.E.) ... | 389 |
| 10. | **Notices of Magazines** ... ... ... ... ... ... | 394 |


CHATHAM:
Royal Engineers Institute.
TELEGRAPHIC ADDRESS: SAPPER, CHATHAM.
Agents and Printers: W. & J. Mackay & Co., Ltd.

PRICE: 1s. 6d. POST FREE. ANNUAL SUBSCRIPTION: 15s. PAID IN ADVANCE.

Digitized by Google

THE MODERN ROOFING MATERIAL,

# "ETERNIT."

ROOFING SLATES.

SHEETS FOR WALLS AND CEILINGS.

INDESTRUCTIBLE,
LIGHT,
ARTISTIC,
ECONOMICAL,
WEATHERPROOF.

Weight, 22 lbs. Laid.

## G. R. SPEAKER & CO.,

**Engineers & Contractors to H.M. Government,**

**29, MINCING LANE, E.C.**

WIRE—"ETRASHEET." 'PHONE—CENTRAL 13174.

# Norfolk House School,

## BEACONSFIELD, S. BUCKS.

**Special Terms to Sons of R.E. Officers.**

**Prepares Boys from 7 to 14 years of age for Public Schools and the Royal Navy.**

THE School House, recently built, with all the latest improvements, stands 500 feet above sea level, on a gravel soil. It is one mile from Beaconsfield Station, whence there is a good service to London in 35 minutes.

Recent honours gained, include Scholarships,

**MARLBORO' (3), CHARTERHOUSE, FELSTEAD, ALDENHAM, HIGHGATE, AND NAVAL CADETSHIP. . . . . .**

Two £30 Scholarships offered yearly to intelligent boys likely to gain Public School Scholarships or Naval Cadetships.

Prospectus, Names of Scholars, and full particulars from

**Head Master, C. T. MARCON, M.A.**

Digitized by Google

Telegrams—"GUNDRADA, LONDON." Telephone—4716 Gerrard.

THE ARMY, NAVY AND GENERAL ASSURANCE ASSOCIATION, LIMITED

HEAD OFFICE:- 217, PICCADILLY (CIRCUS), LONDON, W.

Fire, Theft and Burglary *(Combined).*

Chargers, Hunters, Marine Risks.

# The "Professional" Policy

. of .

# Accident and Disease Insurance

Is Specially adapted for Military and Naval Officers serving in ANY PART of the WORLD, and now covers 30 Specified Diseases.

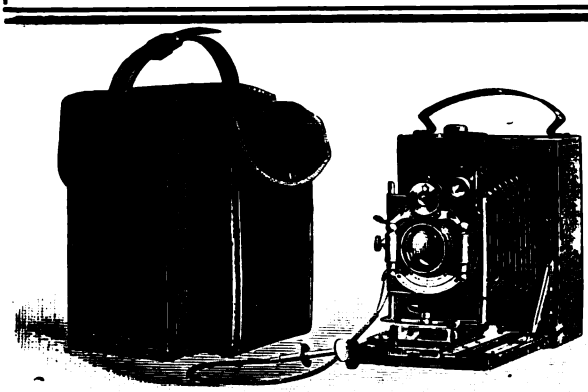
**Revised Prospectus of Extended Benefits on application—**

**217, PICCADILLY (CIRCUS), LONDON, W.**

## Surveying and other Scientific Instruments.

**C. F. CASELLA & CO.,** Instrument Makers to the British and all Foreign Governments, will be pleased to send their Price Lists, and to give quotations or other assistance to Officers requiring Scientific Instruments for Survey or other work.

**11-15, Rochester Row, Victoria Street, London, S.W.**



**THE 'EMPIRE' HAND CAMERA.**

A folding Camera, of best workmanship, designed and made specially for use in the tropics.

QUARTER PLATE SIZE ONLY.

Outfit includes:—Camera, 3 Double Slides, f6 Holostigmat Lens, Diaphragm Shutter, Iso Screen and Leather Case.

**£12 12s. 0d.**

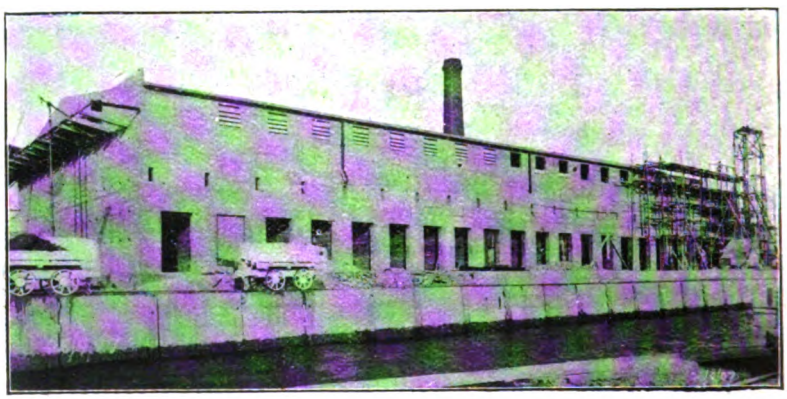
*Write for Photo Catalogue.*

**W. WATSON & SONS,** Limited, **313, High Holborn, LONDON.**

Digitized by Google

# EXPANDED METAL

## SYSTEM OF
## REINFORCED CONCRETE
## AND
## FIRE-RESISTING CONSTRUCTION.



EXPANDED STEEL CONCRETE CEMENT STORE FOR THE WOULDHAM CEMENT CO., LTD., WORKS, WEST THURROCK.

### Specialities:—

**CONCRETE REINFORCEMENT**; 3-in. mesh weights Expanded Steel for Foundations, Walls, Floors, Roofs, Bridges, Reservoirs, Sewers, Conduits, Hoppers, Silos, etc.

**LATHING FOR PLASTER**; Expanded Metal Lathing for Ceilings, Partitions, Exterior Walls, Steel Work Encasing, etc.

**MADE-UP GOODS**; Openwork Partitions, Fencing, Clothes and Tool Lockers, Machinery and Tree Guards, etc.

*Full particulars on application to:—*

## THE EXPANDED METAL CO., LTD.,

**YORK MANSION, YORK ST., WESTMINSTER, S.W.**

**Telegrams: "DISTEND, LONDON."** **Telephones:—819 Gerrard; 1514 Victoria.**


Digitized by Google

# PATENT VULCANITE ROOFING

FOR

FLAT ROOFS, CONCRETE ROOFS
AND WOOD ROOFS.

## ROOF TANKS

FOR

SWIMMING-BATHS, RESERVOIRS, BRIDGES.

**EFFICIENT AND ECONOMICAL.**

**For Waterproofing Existing Faulty Concrete and Asphalte Roofs.**

Will give with the movements of the building due to settlement, vibration, and expansion and contraction, and is guaranteed for long periods.

Special surfaces can be provided to the Vulcanite covering to meet any special requirements.

*Full particulars on application to :—*

**VULCANITE, LIMITED, 118, Cannon St., London, E.C.**
**Laganvale, Belfast,** and at **MANCHESTER.**

(Also Manufacturers of VULCANITE and BITUMEN Sheetings for the Sloping Roofs of Light Buildings, and for use as a Damp-proof Course).

# BULLIVANT & CO., Ltd.,

Manufacturers of

## *STEEL WIRE ROPES*

FOR

CRANES, LIFTS, HOISTS, SUSPENSION BRIDGES, HAULING, Etc.

**DURABLE AND RELIABLE.**

Contractors for . . . .

## AËRIAL ROPEWAYS

Specially designed for conveying Stores, Munitions, etc., across Rivers, Ravines, etc. Can be quickly and easily erected and dismantled. Suitable also for conveying Passengers.

**BLOCKS, PULLEYS, TACKLE, AND ALL WIRE ROPE APPLIANCES.**

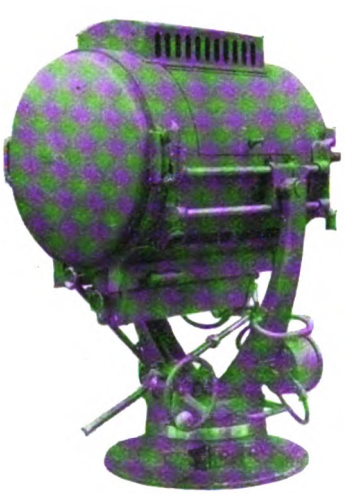
Regd. Office, **72, Mark Lane, London, E.C.**
Works, **Millwall, E.**


Digitized by Google

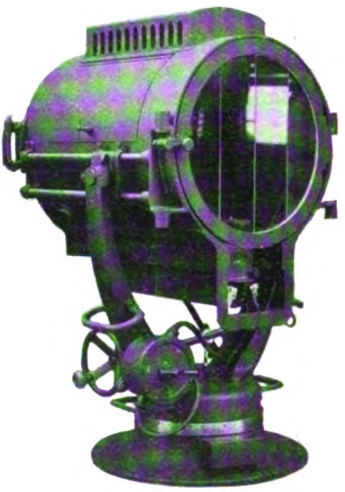
# SIEMENS

# Searchlight Projectors.

**MADE IN ALL SIZES FROM 25 cm. to 200 cm.**



BACK VIEW.



FRONT VIEW.

**35-CENTIMETRE FIELD SEARCHLIGHT.**

Projectors can be fitted with Siemens Patent Horizontal Automatic and Hand Lamp, or Horizontal Lamp for hand feed only. Mirrors of the metallic or glass parabolic type. Single or double Dispersing Lenses. Iris Diaphragm Shutter or Venetian Louvred Signalling Shutter. Electric Control is fitted for Fortress, Battleship, and other use, if desired.

**Full Particulars on Application to M Department.**

## SIEMENS BROTHERS DYNAMO WORKS LTD.,

**Caxton House, Westminster, S.W.**

Telephone : GERRARD 869. Telegrams : "SIEMBRALOS, LONDON."


Digitized by Google

# CONTENTS.


PAGE.

1. ELECTRIC TRACTION ON RAILWAYS. By Philip Dawson, Esq., M.INST.C.E., M.I.MECH.E., M.I.E.E., Consulting Electrical Engineer to the L.B. & S.C.R. (*With Photos*) ... ... ... ... ... ... ... ... ... 329

2. PENETRATION OF THE RIFLE BULLET INTO SNOW. By Major J. C. Matheson, R.E. ... ... ... ... ... ... ... ... ... ... ... 349

3. FRENCH AND ENGLISH METHODS IN FIELD TELEGRAPHY. By Major E. G. Godfrey-Faussett, R.E. ... ... ... ... ... ... ... ... 351

4. A PROPOSED TENSION BRIDGE. By Capt. E. N. Mozley, R.E. ... ... ... 355

5. TERRITORIALS OF THE ROMAN IMPERIAL ARMY, 1ST CENTURY, A.D. By Col. O. E. Ruck, late R.E. ... ... ... ... ... ... ... 363

6. SWALLOW HOLES IN CHALK. By Col. W. Pitt, late R.E. (*With Plate*) .. 365

7. THE R.E. HEADQUARTER MESS (*continued*). By Lt.-Col. B. R. Ward, R.E. .. 371

8. MEMOIR :—

The late Colonel John Roberts Hogg, R.E. By 'A.T.S.' ... ... ... 375

9. TRANSCRIPTS :—

Field Kitchens in the German Army. By Col. E. Hartmann. (*With Photos*) 377

Mirrors for Search-Light Projectors. (Translated from the *Rivista Maritima* by Major E. G. Godfrey-Faussett, R.E.) ... ... ... ... ... 389

10 NOTICES OF MAGAZINES :—

*Journal des Sciences Militaires.* By Lieut. H. L. Woodhouse, R.E. ... 394

*Journal of the Military Service Institution* (*U.S.A.*). By Lieut. A. J. Swinton, R.E. .. .. ... ... ... ... ... ... ... ... 397

*Kriegstechnische Zeitung.* By 2nd Lieut. A. H. Scott, R.E. ... ... ... 401

*Le Bulletin.* By 'E.R.' ... ... ... ... ... ... ... ... . . 402

*Militär Wochenblatt.* By 2nd Lieut. A. H. Scott, R.E. ... ... ... 404

*Nature.* By Major-Gen. W. E. Warrand, D.L., late R.E. ... ... ... 406

*Neue Militärische Blätter.* By Capt. E. G. Wace, R.E. ... ... ... 407

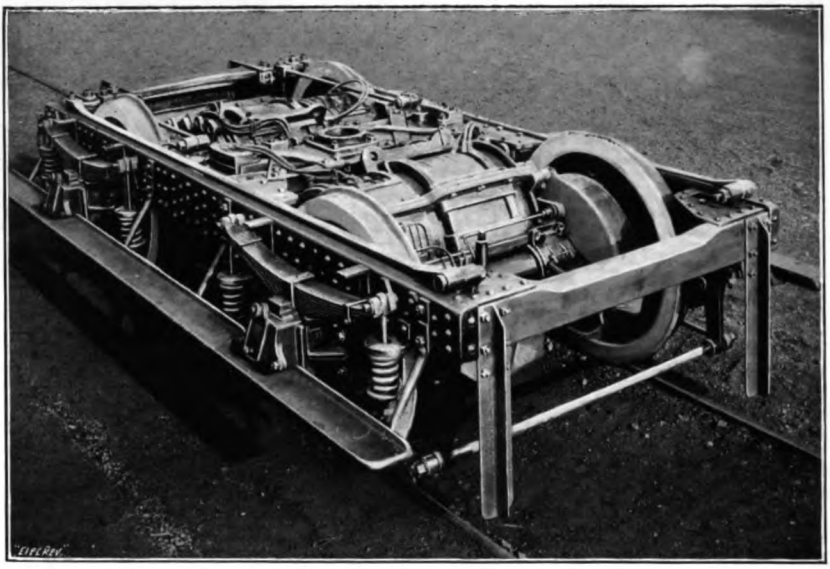
*Rivista di Artiglieria e Genio.* By Col. Sir Edwd. T. Thackeray, V.C., K.C.B., late R.E. ... ... ... ... ... ... ... ... 414


*Authors alone are responsible for the statements made and the opinions expressed in their papers.*

Digitized by Google

Digitized by Google

Digitized by Google



L.B. & S.C.R.—Motor Truck Fitted with two 115-H.P. Single-Phase Motors of Winter Eichberg Type.

& S.C.R.—Interior of Guard's Compartment, showing Motorman's Compartment and High Tension Chamber Open.

Digitized by Google

# *ELECTRIC TRACTION ON RAILWAYS.*

*By* PHILIP DAWSON, ESQ., M. INST. C.E., M.I. MECH. E., M.I.E.E., *Consulting Electrical Engineer to the L.B. & S.C.R.*

THE subject of railway electrification is one involving so many interests and covering so many branches of engineering, as to make it impossible for me, in a single article, to do anything but briefly summarize the principal points dealing with electric traction on railways. I think it will be more interesting and useful to deal generally with the whole subject, rather than to deal in detail with a single one of the very many numerous points connected with this important engineering problem.

The question, generally, can be divided into two entirely different problems, the one dealing with the electrification of lines already constructed, whereas the other is concerned with the selection of a system of traction for new lines which are either proposed or are already under construction.

The former problem is the one which is most generally met in Great Britain, and which therefore presents the greatest interest in this country, whereas in our colonies and many foreign countries, the latter is the one which presents the greater importance.

When dealing with this question it is naturally necessary to carefully consider and weigh the various conditions which obtain, when making investigations as to which system of traction should be adopted for a new line, or when discussing the problem as to whether advantage can be reaped by replacing steam traction by electrical haulage on an existing system. Amongst the conditions which have to be considered may be mentioned such points as whether coal is produced in the country, the price at which such coal can be landed on the steam locomotives, and, where coal is expensive or has to be imported from abroad, whether sufficiently large and continuous water powers are available for supplying the requisite energy necessary for operating the lines under consideration by means of electricity instead of steam.

As far as new lines are concerned, a very serious point arises as regards the nature of the country, that is to say as to whether it is level or mountainous, for in the latter case—owing to the special features possessed by electric locomotives—the adoption of the latter enables very much severer gradients to be allowed for, than would be possible if it were proposed to construct a main-line railway to be operated by steam.

Digitized by Google

The cause of this very important difference in construction between a railway intended to be operated by steam and electricity, is accounted for by the fact that, for the same weight on the driving wheels, an electric motor can exert a much greater tractive effort than the steam engine, in consequence of the electric motor exercising a steady torque on the driving wheels, which the steam engine does not and cannot do. In the case of the steam locomotive, the ratio of maximum tractive effort to weight on the driving wheels is not much over 16 per cent., whereas experience with electric locomotives has shown that in their case this ratio can be taken at nearly double the amount, namely from 25 to 30 per cent. With electric traction it is possible and easy to drive every axle of a locomotive by means of an electric motor, and no mechanical coupling is necessary between the wheels, whilst, with steam adhesion, this can only be obtained by mechanically coupling the wheels of a locomotive. For mountain work, particularly in the United States of America, steam locomotives of exceptional weights have to be used; thus the heavy trains in operation on the Atchison Topeca and Santa Fe line are hauled by a Decapod, the engine of which weighs 128 tons without the tender, while the latter weighs 72 tons, or a total weight of engine and tender of 200 tons. This weight is by no means exceptional; there are many locomotives in America which exceed it.

In the case of the locomotives I have mentioned, not more than 90 tons are available on the driving wheels, which, on the basis of 16 per cent., would give just over 13 tons available for tractive effort. Compare this with the electric locomotives on the New York Central Railroad, the total weight of which is 95 tons, 70 tons of which are available on the drivers, and taking 30 per cent. of this as a maximum tractive effort, we find 21 tons, or nearly double that which was possible with the steam locomotive, including the tender of over double the weight. But there is another important factor which must enter into consideration, namely, that as far as steam locomotives are concerned, the limit of size of a single locomotive has been reached, and this may be said to be somewhere in the neighbourhood of 2,000 H.P.

There is nothing as regards finality in connection with electric locomotives, which have the additional advantage that, in consequence of the properties of the series wound type of electric motor, they can at starting and for some considerable time, according to their design, stand overloads of 100 per cent. or more without damage.

Before considering more in detail the various reasons which have brought about electrification in the past, or will bring it about in future, or before entering into a discussion of the various details, it may be as well to point out that the only argument which lies at the bottom of electrification, either of existing lines or of new lines, is of a financial nature. Electricity must either reduce working expenses, increase the gross receipts, decrease the capital expenditure required in the

Digitized by Google

construction of a given line, or enable a larger number of trains to be operated over an existing system than will be possible with steam. This means saving the additional capital expenditure which will be required for increasing the number of tracks and station platforms, which would be involved if a train service were increased whilst retaining steam operation. In any case where it is impossible to definitely prove that some such financial advantages exist, as have been referred to above, there can be no question of considering electric traction.

The principal advantages from this point of view in connection with long-distance lines arise in the case of new lines from (1) the cheaper construction, possibly owing to the feasibility of adopting more severe gradients with steam than with electric traction, and—in the case of existing steam-operated lines—in consequence of the saving in operating costs (which can be obtained where coal is expensive and water power abundant); and (2) the further benefits of rendering a country self-supporting and not dependent on export coal from other countries. Incidentally, the installation of electric traction under these conditions offers additional advantages of rendering electric power available for manufacturing and other purposes along a railway system, which might otherwise never have been developed.

In this investigation of the subject of electrification there is however a very serious point to be borne in mind particularly by the military engineer, namely that where railways are built for electric traction and entirely operated electrically, the risks of interrupting traffic in case of war may be much more serious than if steam locomotives are utilized. It is evident however that there are only certain cases in which this consideration applies, and the proper weight can only be given to it when all the various contingent circumstances have been seriously weighed and carefully considered by those best able to judge on the spot of their relative value.

Having thus briefly summarized a few of the advantages presented by electric traction in the case of long-distance lines, we will consider in a similar way both the advantages which will accrue to British railways by the electrification of their suburban lines, and also what are the reasons which will weigh most in the minds of the railway authorities in favour of such a change.

In this connection it should be clearly understood that the only lines on which electric traction, as far as this country is concerned, can at present be discussed, are those so-called suburban lines on which the distance between stations are comparatively restricted from ½ to 1 mile, and over which a very frequent service of trains have to be operated. Thus, in the case of London, one may roughly call the suburban system of a railway anything which is within say 20 or 30 miles of Charing Cross. The principal advantages of electric traction in this case are due to the property possessed by electric motors, which will enable them to produce what is called

Digitized by Google

rapid acceleration, or, in other words, to obtain the maximum travelling speed in a very much shorter time than is possible with steam. Thus taking the extremes, whilst the maximum which has been practically possible with steam, is to obtain a speed of something like 27 miles an hour in 50 seconds, the experiments at the General Electric Company's works in America have shown that it is quite feasible with electricity to obtain a speed of 40 miles an hour in 30 seconds. This latter acceleration is of course much too high from the point of view of personal comfort to the travelling public, and with electric traction on suburban systems it is more usual to obtain anything from 25 to 32 miles an hour in 30 seconds.

This property enables the average speeds of trains to be very considerably increased, and, according to circumstances, anything from 25 to 50 per cent. to be deducted from the time required for travelling between any two stations on the suburban line. Thus in the case of the Brighton Railway (for the electrification of which I am responsible), on the run from London Bridge to Victoria and *vice versâ*, we shall save 11 minutes; for whereas with steam it takes at the present moment 36 minutes to do the distance, with electricity we shall be able to easily maintain a service with stopping trains, running the distance in 25 minutes. There are however many other advantages of equal importance which must be taken into consideration when discussing the question of electrification of suburban systems.

The increase in the speed of travelling possible with electricity will be useless, unless much more frequent services are at the same time installed than are usually adopted with steam practice, and again in this instance electricity comes to the aid of the railway manager.

Steam locomotives may be considered very economical when they run long distances and haul heavy trains for such distances with few or no stops, or in other words when they exert tractive effort during the majority of the time they are running; thus a steam locomotive only uses something in the neighbourhood of 4 lbs. of coal per H.P. hour, or according to the weights of train anything from 35 to 60 lbs. of coal per train mile.

The moment the locomotive is utilized for suburban work this state of things entirely disappears, for experience clearly shows that the amount of fuel burnt during the time a suburban locomotive is in actual service, is very little less than that which would be burnt by such a locomotive if it were running and exerting tractive effort during the whole time that it was in service. In other words, the amount of fuel consumed per train mile, or per ton mile, is very much greater in the case of a locomotive doing suburban work than of the main line engine above referred to. It clearly follows that it must be more economical to have as few and as large suburban trains as possible, rather than to have a larger number of smaller trains, for the cost in the case of a steam locomotive is nearly proportional to

Digitized by Google

the train mileage, practically irrespective of what the ton mileage hauled may actually be. In the case of electric traction the case is quite different, for here the amount of energy consumed is proportional to the ton mileage, and under these circumstances there is very little difference in the operating expenses caused by running a much larger number of small trains, rather than a small number of large trains. It will therefore be seen that electricity enables a general manager of a railway not only to increase the average speed of travelling, but also the frequency, which, as I have shown, is absolutely essential if full benefits of increased speed are to be fully realized.

Up to the present in discussing electric traction we have only compared electric and steam locomotives, and it must now be pointed out that electricity enables the use of what is known as the multiple unit control, that is to say the equipment of a given number of carriages with motors, each motor car hauling, or being capable of hauling, a given number of trailers, and a unit train being made up of one or more motor coaches and trail coaches as may be considered best.

The multiple unit system of control thus enables any number of these unit trains to be coupled up and driven by one man just as if they constituted but one train. Such multiple unit trains can be made up of any number of coaches as desired, and owing to the comparatively reduced maximum speed at which trains of this description have to travel, it is admissible for a motor coach to push a trailer coach, and thus to form a unit where found advisable consisting of one motor coach and one or more trailer coaches equipped with controlling apparatus, so that the train can be driven by motormen from either end. The use of multiple unit trains and their great advantages are at once appreciable when the question of termini have to be considered, as is practically always the case when railway electrification is under discussion. At the present moment, taking a terminus like Victoria Station, it takes six minutes after the arrival of a train alongside the platform before the same platform can be available for another train. This is due to the fact that after a train has arrived the lines have to be cleared, in order to enable the engine to be backed on to the train in readiness to take the same out again, and that as soon as this has been done, the line has to be kept clear for the engine which brought the train to be run out again to a particular siding, on which it has to wait until another train is brought in, which it has to haul out.

With the multiple unit system of electric traction this loss of time entirely disappears, as all that is required is the time at which it takes the motorman to take off his switch handles and walk from one end of the train to the other. This time is probably less than would be required to empty and fill a train, but provided properly designed carriages are used with side doors, and not with the American form of

Digitized by Google

end doors, from 1½ to 2 minutes is the maximum time required for any train to occupy a platform. The enormous benefits conferred by this saving of time will be appreciated from the fact that at a terminus such as Victoria Station, at the crowded hours of the day, it is very difficult, not to say impossible, with steam traction to add a single train to the existing services, a very severe handicap on a railway, considering the constant demand of the travelling public for increased train facilities, particularly during the rush hours of the day.

In other words, the introduction of electric traction will enable a railway—taking into consideration the small proportion of long-distance trains compared with suburban trains—to more than double the number of trains on a given system, without either increasing the number of tracks or the station accommodation. The cost of operating and maintaining electric trains is certainly smaller than that involved with steam trains, but the advantages I have shown which are possessed by electric traction are so great as to make it unnecessary at the present moment to discuss economies which will undoubtedly result in consequence of railway electrification. For as already mentioned in order to make electric traction successful financially, the number of trains must be considerably increased, and under these circumstances it can be safely stated that although smaller trains will be operated, the total train service can be doubled by means of electrification without involving any appreciable increased working expenditure besides that required for electrically equipping a system, which figure is a very small one when compared to the expenditure which would be necessary if increased services had to be put into operation and hauled by steam.

The introduction of electric traction on the suburban system of one of our great railways, as for instance on the London, Brighton and South Coast Railway, would bring many other advantages in its train, some of which are of the utmost importance. Supposing for example a time when the whole of the suburban line between Victoria, London Bridge, Sutton, and Croydon are equipped with electric traction, and that all the local trains running to Sutton or Croydon are operated electrically, the question will have to be considered as to what shall be done with the main line trains after they reach either Sutton or Croydon. At the present moment most of the trains divide at these two stations, one portion running to the City and the other to the West End terminus. Such a division involves loss of time, time which would be no greater if from this point electric traction were adopted instead of steam for hauling the trains respectively to Victoria and London Bridge. The cost involved by such a change would be very slight, as the electrical equipment, overhead system, feeders, switch cabins, etc., will already be available and will not have to be increased in order to handle main line traffic. The advantages of such a step are obvious, because thereby the

Digitized by Google

immensely valuable space now occupied by locomotive sheds, locomotive repair shops, coal sidings, turntables, ash pits, water towers, and suchlike, would be rendered utilizable for other purposes, and furthermore considerable time would be saved at the termini owing to the fact that an electric locomotive, when standing, does not use current, and if switched off can be left by itself without any attendant, ready for instant use, whereas this is not the case with a steam locomotive. There is however one very great advantage which would be reaped by such a change, and which is, I think, not sufficiently appreciated by many engineers, namely the great saving in corrosion of steel work which would be effected by the absence of the gases caused by steam locomotives. What this corrosion may mean, may be seen by the fact that some bridges have had to be renewed within 10 years, where they are subjected to the hot gases and sulphurous vapours emanating from steam locomotives. As long as steam is employed it is practically impossible to paint steel structures with any reasonable chance of success where they are within a few feet of steam locomotives, whereas, if electricity were adopted, they could always be properly painted and kept in working order and their life immensely prolonged.

In considering the advantages of electric traction, it must not be forgotten that electric locomotives are not only more efficient than steam, but that they cost less to maintain and that the hours of service which can be got out of an electric locomotive per annum are much greater than those which can be obtained from any steam-driven locomotive.

This experience has shown that in the case of steam locomotives operating suburban trains, out of the total life of a locomotive, which may be taken at about 25 years, only about 28 per cent. of this time is utilized in actually hauling trains. Although it is only exercising drawbar pull during 28 years of its total life, it is consuming fuel and wearing itself out during, approximately, 76 per cent. of its life, the remaining 24 per cent. being spent by it in repair shops and in generally being overhauled and maintained. In Germany it is found that the average working hours per locomotive average out at about 12·8 hours per day, but that out of this, two hours per day are necessary for replenishing the engine and for getting it under steam, as well as for raking fires and cleaning smoke tubes at the end of a day's work. A further hour is required every day to take in additional fuel and water, and when the fire is out an additional hour for washing out the boiler, so that out of the 12·8 hours in which it is actually supposed to be engaged in doing work it is only effectively in use 8·8 hours. Figures show that, as regards the Prussian Government Railways, out of a total number of steam locomotives owned, 22½ per cent. are not available as they are undergoing repairs, from which it will be seen that out of the total number of steam locomotives owned, only

Digitized by Google

54 per cent. are actually in service. The repairs of steam locomotives as a rule are most important in connection with their boilers, which puts the whole locomotive out of service, whereas with electric locomotives, repairs are of such a nature as not to put them out of service for any considerable time, as most defects or worn-out parts can quickly be replaced without laying up the engine, which is not the case with steam locomotives.

The calculations which have been made by the Prussian Government have led them to conclude that, having equal work and allowing an equal amount for reserves, 36 per cent. less electric locomotives are required than would be necessary if steam locomotives are employed.

I hope that I have been able to show that, as regards electric traction in this country, there is undoubtedly a great deal to be said in its favour from every point of view, as far as the electrification of local and suburban lines is concerned on which there exists a very intense and heavy traffic, and that as far as foreign countries are concerned there are many cases where the equipment of long lines may prove exceedingly satisfactory.

Having thus briefly examined what is the actual position as regards the introduction of electric traction on railways under varying conditions, we will briefly consider the course followed by electric traction after its first practical introduction at the technical exhibition in Berlin in 1879. Here a small electric locomotive, built by Messrs. Siemens Halske, hauled a few small trailer coaches carrying 12 or more passengers in all along a narrow-gauge line laid in the exhibition grounds, current being supplied from one rail and returned to the other. The successful operation of this small experimental line soon led to the adoption of electric traction on a larger scale in connection with tramways in Germany and in Ireland. In Germany, between Frankfurt and Offenbach, in Ireland, at the Giant's Causeway and between Bessbrook and Newry. It was however in America that the great future for electric traction was first realized on a large scale, and its introduction on the very well-known West End tramway system at Boston about 1889, was the starting point for what may be called the wholesale electrification of all existing tramways in America. The increase in traffic and decrease in working expenses resulting from electric traction, were such as to speedily open the eyes of European financiers and tramway men to the great benefits to be derived from electrification. Germany, France, and England soon followed suit, the first great success being achieved in England by the Bristol Tramways Company, for the equipment of which I was largely responsible, and from that date to the present time so much has been done that practically speaking nowadays there does not exist a town of any size in the United Kingdom which has not its own electric tramway service.

The development of the electric motor was very rapid in conse-

Digitized by Google

quence of the large demands produced by electric tramway construction and equipment, with the consequence that in a few years motors were produced which only a short time beforehand would have been thought quite impossible, and the result of this experience was that the general knowledge of how to get over difficulties and to improve efficiencies in outputs, was very largely increased. It is not therefore surprising that the City and South London Railway Company, when faced with the problem of what method of traction to employ on the first deep level tube built in the world, as well as the Liverpool Overhead Railway, when faced with the proposition that in consequence of fire risks steam haulage on their system was impossible, both immediately decided to adopt electric traction. Shortly after this the Baltimore and Ohio Railway Company, having built a long tunnel under the City of Baltimore in order to avoid difficulties due to ventilation, decided to haul the whole of their trains through this tunnel by means of electric locomotives, and these were each equipped with four 6-pole motors, each motor being built to give out 360-H.P. for one hour. The total weight of this locomotive was 85½ tons, its normal drawbar pull was 42,000 lbs., and at starting it was able to give a drawbar pull of 60,000 lbs. In the United States, as is well known, there were a very large number of steam railways built solely for hauling local services, such as the various elevated railways in New York and Chicago. These, before the advent of electric tramways, had done very fine business, but with the increased speed and frequency produced by electric traction on tramways they soon found themselves obliged to introduce electric traction themselves. The results which they anticipated from this conversion have so far been nearly universally realized in the United States. It may be said at once that although electric traction on railways has not been introduced till comparatively recently, it had been thought of in the early days, and as far back as 1885 an electric locomotive, built by Mr. Leo Daft, had been experimentally operated for some months over the lines of the Manhattan Railway in New York.

The success obtained by electric traction on railways soon resulted in many other railways adopting this method of haulage, particularly in those cases where steam was either not available or was impossible, as for instance in the case in Paris with the Orleans line, in connection with its new terminus at the Quai d'Orsay.

The beginning of this century first brought home to the railways the very disastrous competition which the introduction of electric traction enabled tramways to create, and it may be said with truth that it is the electric tramway which will be largely responsible for the introduction of electric traction on most of the suburban systems of our main line railways. It is to this cause that must be traced the adoption of electricity by the Lancashire and Yorkshire Railway for

Digitized by Google

its line from Liverpool to Southport, as well as the electrical equipment by the North-Eastern Railway of their line between Newcastle and Tynemouth, and in both cases the result appears to have come up to the expectation of the railway company's officials.

In considering the problem of railway electrification, it is necessary to point out that there would appear to be only two rational courses which can be pursued by a railway in order to meet tramway competition. The one would involve the entire shutting down of the whole suburban system, no trains stopping within say 15 miles of the terminus. This would mean that a very large number of lines, sidings, and stations which can only be used for suburban traffic would have to be shut down and their capital value, representing a very large figure, written off, as well as the decrease of gross receipts (a very large item) which would result from the entire abandonment of local traffic.

What tramway and motor omnibus competition means, can be gathered from the statement that five railway companies—the Great Northern, the London and South Western, the London Brighton and South Coast, the Great Eastern, and the South Eastern and Chatham—carried between them nearly 35,000,000 passengers less in 1907 than they did in 1903, and this loss of passengers accounted for the loss in money of over £177,000. It should be noted that this loss is constantly increasing, owing to the extension of tramway systems, and the reduction of local traffics by railways can only greatly increase the loss, whilst but very slightly decreasing the working costs of the system, and it would therefore appear that, even if the Board of Trade and the Government could allow railways to entirely abandon the whole of their suburban traffic, the losses resulting from such a step, both as regards receipts and writing off useless capital expenditure, would be such as to make such a solution a most unpractical one.

The one method of dealing with this difficulty is by increasing the average speed and frequency of the trains, which, as has been shown, can only be done by electrification. Experience has shown that in Great Britain at least, the average speed of tramways cannot exceed about 10 miles per hour, that under favourable conditions of railway traffic the limit of tramway travel is about 5 miles, and that everything beyond 5 miles will come back to the railway, provided electrical service is introduced. Facilities for travelling always increase the travelling habits of the people, experience in this country amply confirms that of other countries, and conditions are such that if all that can be secured by the railway companies in consequence of electrification is simply to recuperate their lost ground, such a step will be amply justified. Probably the greatest electrification of a railway which has ever been carried out has taken place in New York City, where for about 30 miles outside New York both the

Digitized by Google

New York Central and the New York New Haven and Hartford Railways are running electrically, the local trains being operated on the multiple unit system, whereas trains going long distances are operated by steam until the electric zone is reached, when electric locomotives take the place of steam. The primary causes of this change was the dangers caused by the long tunnel through which both railways have to pass on their entry into New York, and the necessity of entirely doing away with steam if these dangers were to be avoided. The results obtained by this conversion have been entirely satisfactory to the railway companies, and Mr. Smith, the third vice-president and general manager of the railway, informed me last summer that electrification had been the salvation of his railway. The railways already opened have given such satisfactory results that the Illinois Central Railway, which has an enormous passenger traffic in Chicago, has decided to operate the whole of its suburban system by electric traction, a step the importance of which can scarcely be appreciated at its proper value. But it is not only in America that large things are being considered, for Germany, with its very excellent State-owned railway system, has been carefully watching events, with the result that after most thorough investigation of everything that has heretofore been done, the Prussian Government has definitely decided to convert the whole of the Berlin urban and suburban railway system to electric traction at an expenditure of some £10,000,000 sterling.

Having thus generally considered the reasons which should in the near future bring about the very general adoption of electric traction on railways, we will now discuss the various systems by which electricity can be most satisfactorily utilized for traction purposes.

For all practical purposes there are three systems, and three only which can at the present be considered for traction purposes, and which are as follows :—The continuous, or direct current system ; the three-phase system ; and the single-phase system.

The first of these systems is that which has so far been most generally adopted ; it involves the use of continuous current motors of a series type, generally very similar in design and construction to the electric tramway motors, which are so well known to everyone. These motors are operated in groups of two or four, by means of what is known as a series parallel control, by which the motors are first started in series with each other, and afterwards—when speed has been obtained—put into parallel.

The usual difference of potential or electrical pressure between the terminals of these motors is from 500 to 600 volts. Motors have been constructed at the terminals of which it is possible to employ 1,000 volts, and by keeping a group of two motors of this description constantly in series it has been possible to utilize pressure of 2,000 volts with continuous current motors. It is evident that in this case

Digitized by Google

all the controlling apparatus and the lighting circuits must be insulated to 2,000 volts, and furthermore, even supposing 200-volt lamps were used for lighting purposes, ten such lamps would have to be put in series, as otherwise a motor generator would have to be insulated on the coach or on the train, in order to convert a high pressure continuous current into lower pressure continuous current. It is claimed by some designers that motors can be constructed to satisfactorily operate at 2,000 volts, and by putting two of these in series it might be possible to utilize a line pressure of 4,000 volts, but such construction has never yet been carried out in practice.

It must be noted that the introduction of such high pressures would introduce very serious dangers in maintaining and looking after motor equipments, as there must always be a liability of getting a shock with the full line pressure when touching any part of the apparatus, and furthermore all the motors and the apparatus generally would have to be insulated to withstand the working pressure. It must further be noted that in order to regulate the speed of continuous current motors, it is necessary to regulate the pressure between the terminals of the motors, and that for a considerable stage of the operation this can only be done by absorbing volts by means of resistances, which is necessarily an inefficient mode of doing this. This method of traction has been utilized in connection with railway work, and requires the use of a third rail, insulated and situated above the level of the ordinary rails, which serves to conduct current to motors on the train.

In the case of the Baltimore and Ohio line, the railway authorities at first used overhead conductors to bring the current to the train, but the construction proved so cumbersome that it had to be abandoned in favour of the third rail system. The reason for this will be easily appreciated when we recollect that for starting an electric train, according to the weight of the equipment of the train, anything from 800 to 2,000 kilowatts may be required, which, at the normal pressure utilized at the present moment for continuous current work, would amount to from 1,600 to 3,500 ampères. From this it is seen that (considering that more than one train will frequently have to start and take its supply from the same conductor) the size of this will have to be such as to make it impossible under such conditions to utilize anything but the third rail system of conductors at the pressures usual with continuous current motors. In other words, as far as railway work is concerned, the continuous current system makes the third rail essential.

Where earthed returns are used, the Board of Trade where it has jurisdiction limits the return drop to 7 volts. With the very large currents required in railway work this practically means the adoption of a fourth or insulated rail, as has been done by the District and Metropolitan and the Great Western Railways in London. The

Digitized by Google

very large amounts of energy required for railway work have to be distributed over considerable distances, and in order to secure both economy as regards first cost, as well as economy in generation of current, it is necessary to reduce the number of power stations as much as possible, or, in other words, to centralize the same to the utmost possible safe extent. Under these conditions, in order to transmit economically as well as to reduce the size and quantity of feeder cables required, the current is usually generated in the form of alternating current. Generally two or three-phase currents are used, and these are transmitted at varying pressures according to circumstances. The usual maximum generating pressure for economical machine construction is somewhere in the neighbourhood of 11,000 volts, and the current is frequently distributed at this pressure and transmitted to sub-stations, where the pressure is reduced to from 350 to 500 volts, according to circumstances, by means of static transformers, and then converted by means of rotary converters into continuous current at the pressure of 500 to 650 volts, at which it has to be supplied to the line. Instead of static transformers and rotary converters, motor generators can be used, the motors being wound for the pressure at which three phase-current is supplied, provided this does not exceed some 11,000 volts.

For long-distance transmission this pressure is not sufficient, and in this case the pressure at the generating station is transformed up by means of static transformers to whatever transmission pressure has been settled upon.

In order to increase the efficiency of the cables and decrease the size of the sub-station converting plant, in many cases recourse has been had to storage batteries having anything from 1,000 to 5,000 or 6,000 ampère hours capacity, and such installations have for example been put down in the case of the Lancashire and Yorkshire Railway, and given very good results.

Only careful calculations in every individual case can possibly give the amount of sub-station plant which would have to be put down, but, generally speaking, it can be stated that experience has shown that the sub-station plant is anything from one and a-quarter to twice the capacity of the plant installed at the generating station.

The second system is the three-phase system, which has been used with quite satisfactory results on some long-distance railways in Switzerland and Italy, as well as several short mountain lines in Switzerland. In this case the current is usually brought to the motors by means of overhead conductors, two in number, the rails acting as a third conductor; at all points and crossings the overhead conductors which carry different phases have to be separated from each other by insulating material, and furthermore the collecting device on the top of the cars or locomotives have also to be insulated in a similar way from each other. Experience has shown that

Digitized by Google

3,000 volts is the safe maximum pressure to be utilized between two such working conductors. It therefore follows that for long-distance lines, sub-stations containing static transformers will have to be put down in order to reduce the pressure to that at which the current has to be supplied to the working conductor.

The last method, and the one which has recently been most perfected, is that known as the single-phase system. In this method single-phase alternating current motors fitted with commutators are employed, the design of which is in every way very similar to the latest form of continuous current traction motor, and which in fact are so constructed that they can equally well be operated either by continuous or alternating currents. The maximum pressure at which the current is supplied to the terminals of these motors varies, according to their type, to from 300 to 750 volts, this latter pressure being that at which the compensating repulsion type of motor, as designed by Dr. Eichberg and constructed by the Allgemeine Elektricitats Gesellschaft, can operate at. The motors constructed by most of the other makers are what is called the series type, and in this case it has not been practical so far to use current at greater pressure than 300 volts at the terminals of the motors.

In this case the current has been supplied at a pressure as high as 22,000 volts to the working conductor, from which it is collected by means of sliding contact or bow collectors, and transmitted to static transformers on the car, which transform the current to the pressure at which it is utilized in the motors. All the controlling and auxiliary apparatus is in the low-tension circuit, and the same applies to lighting and heating. All the speed regulation is done by means of varying the steps of the transformer, by which the voltage of the motor terminals can be varied as may be required. The single-phase motor has the advantage of possessing practically all the qualities of the continuous current series traction motor, and is therefore most eminently suitable for traction work, and it will be seen that, as regards line pressure, there is no reason why anything up to 25,000 volts should not be used. As a matter of fact, it may be supposed that for ordinary suburban work about 10,000 volts would be found sufficient. The advantages of this pressure will easily be realized when it is seen that it is about 20 times higher than that which has heretofore been the working pressure in connection with continuous current railway working, or, in other words, trains requiring current of from 1,500 to 3,500 ampères at 500 volts, on the basis of 10,000 volts, would only require from 75 to 175 ampères. It will also be obvious that, taking 10,000 volts as working pressure, this can be generated directly in the machine, transmitted and utilized in the overhead line, all at the same pressure, thus doing away with sub-stations and all necessity for static transformers, and the necessary and complicated switch gear required by same.

Digitized by Google

In comparing the single-phase system with the continuous current, it may be stated that the single-phase motor is from 15 per cent. to 25 per cent. heavier than the corresponding continuous current motor, and in addition to this there is the weight of the electrical transformers. It follows that, for the present at least, single-phase equipment of a train must be more costly than the corresponding continuous current equipment, as regards the question of weight of a complete train equipped with single-phase motors, which will, under ordinary conditions, probably not be more than 10 per cent. heavier than the same train equipped with continuous current plant. There is no reason to anticipate that cost of maintenance should be materially greater with single-phase than with continuous current apparatus, and I think it will be admitted that, if there are any material advantages from a railway point of view to be gained from the addition of 10 per cent. in weight of the trains, no railway man would hesitate one moment in adopting such additional weight.

Taking the cost of current at anything from one-third of a penny to one half-penny, such additional weight would only mean an extra cost of something like ½d. per train mile, which is quite insignificant when we consider the fact that locomotive charges at the present moment on our railways amount on the average to about 1s. per train mile, of which fuel is accountable for about half. In considering these figures it must be recollected that they are for the average train mile on our railway systems, and that considering the bad conditions under which locomotives work when hauling suburban trains, if figures were available only for this branch of the service they would probably come out much higher.

The only disadvantages claimed against the single-phase system, as compared with the continuous current system, are :—

(1). The additional weight and consequent increased first cost.

(2). A slightly lower efficiency of the motors.

The only rational basis of comparison is one instituted between two trains which are identical except for the system of electrical equipment. The maximum difference between the two systems under these conditions may be taken as represented by an increase of about 10 per cent. in the total train weight. The cost of the single-phase train equipment is certainly higher than that of the equivalent continuous current plant, but this item cannot be considered by itself and independently of the whole system. For the continuous current motor means converter, sub-station plant, and additional cost in feeding and distribution. No general rule can be laid down as to what this may mean, and each case will have to be investigated on its own merits, but for any comprehensive large scheme there should be a saving on the complete installation—including power and sub-stations—of from 20 to 50 per cent. It must be remembered that even if power is purchased from outside, in making the selling price the entire capital

Digitized by Google

cost, as well as cost of maintenance of the sub-station plant, would have to be provided for in the price at which power is purchased.

As regards efficiency, although it is true to say that for the smaller sizes continuous current motors are more efficient than single-phase motors, it must not be forgotten that if the power generated were taken into consideration the continuous current system involves losses in the sub-station transformation, not existing in the case of the single-phase system. With the net results that as regards this point there is little, if anything, to choose between the two systems, the results appear to be in favour of the single-phase system.

Having thus discussed the various systems available for electrification purposes, we will now examine what, from the ordinary railway man's point of view, is the system which will best meet his complex requirements.

It is obvious that the whole question of the selection of the system to be adopted narrows down to the choice of one of two recognized systems, *i.e.*, the continuous current requiring the use of a third rail and the high-tension single-phase current employing an overhead working conductor; the choice principally depends upon the consideration of the three following points:—

(1). The advantage or disadvantage of the third rail, as compared to overhead construction.

(2). The first capital cost of installing the continuous current third rail system, as compared to the single-phase system, taking into consideration the total cost, including power station, sub-station, transmission and distribution system, as well as equipment of line and rolling stock.

(3). The comparative economy in operation and maintenance of the continuous current and the single-phase system.

As regards the first point, at the time when electrification of the L.B. & S.C. Railway was being considered, the chief engineer of the company, Mr. C. L. Morgan, carefully considered the matter, and reported that:—

The third rail continuous current system was especially objectionable for the following reasons:—

(*a*). In the event of a derailment of a train the third rail would almost certainly be disturbed and thus add to the consequent dislocation of traffic.

(*b*). The line could not properly be packed and maintained without great risk to the platelayers; or as an alternative this work would have to be done during the short time at night when the passenger trains had ceased running and the current cut off, but this could not be done on most of our railways if goods were also worked by electricity, as the largest portion of the goods traffic is worse at night.

Digitized by Google

(*c*). Damage would be certain to arise with consequent dislocation of traffic in unloading materials at night for repairs and renewals.

(*d*). The third rail cannot be fixed in station yards and for "through crossings" without being foul of gauge, but if so fixed it would be a source of great danger to the staff engaged in shunting and marshalling operations.

(*e*). In cases of a heavy fall of snow considerable interruption of traffic would probably ensue.

(*f*). In many cases the structural alterations to, and probable reconstruction of, station platforms and bridges would become necessary to allow of a third rail being kept clear of gauge.

(*g*). Considerable expenditure would become necessary in alterations to, and diversions of, point rodding and signal connections, and on the London viaducts this would apply to water and gas mains.

It is true that this report was based on the consideration of the ordinary third rail, and that recently, particularly on the New York Central, the protected under-running system of third rail has been successfully put into operation, and this system differs materially from that adopted on the North-Eastern and Lancashire and Yorkshire, and on other European lines so far electrically equipped. This new system does not however obviate the disadvantages inherent in the third rail system.

From the point of view of the servants of the company this system possesses advantages, for on crossing or walking along the line, they would be less liable to damage by electrical shock, although the grave inconvenience in crossing the line, involved mechanically by the presence of the third rail and the structures supporting it, would not be removed; on the contrary, if the third rail system as adopted on the New York Central were installed, the height of the third rail structure would be considerably increased, with consequent increase of difficulties to the staff of the railway.

The increase in height necessitated by a protected third rail, in which the contact is made on the lower portion, would render it far more objectionable than the ordinary third rail as adopted in this country, from the point of view of greatly increasing the difficulties of getting the necessary clearances between the bridge girders, station platforms, and rolling stock, as well as from considerably prolonging the gaps which would be necessary at points and crossings, since with the under-running protected form of third rail it would be quite impossible in most cases to find room for the erection of any contact rails wherever points and crossings had to be dealt with. That this is the case is amply proved by the New York Central Railroad, where,

Digitized by Google

at most of their points and crossings, very heavy and cumbersome overhead structures have had to be erected to carry an overhead third rail, in consequence of the aforesaid gaps, with a consequent complication of having to fit the motor coaches or locomotives, as the case may be, not only with third rail shoes, but also with a contact arrangement for collecting current from overhead conductor rails.

It must furthermore be recollected that any derailment which might occur would, to a certainty, involve very serious damage to the third rail, and a very considerable time would be necessary to put this right again, as the adjustment of the exact position of the third rail relatively to the position of the running rail has obviously to be made with the greatest accuracy.

As already stated, it is important to maintain the relative position of the third rail and the track rails, and this is rendered difficult by the fact that as a rule the third rail is only connected to every fifth or sixth sleeper; this renders the maintenance of the accurate relative position of the third rail and track rail exceedingly difficult in practice.

Mr. A. D. Williams, an American engineer who has carefully investigated the question of the third rail, states that it has proved a great source of danger and difficulty in connection with wrecking operations after an accident; this would particularly be the case if by any chance some coal trucks were to get off the line, with the certain result of a heavy short circuit between the third rail and the permanent way, no matter what the system of third rail construction adopted. Such a short circuit might even result in the coal being set on fire, with the additional dangers and risks of fire added to those of the live conductor. After an accident of this kind the third rail could not be replaced until the track had been permanently fixed; this would take a considerable time, and meanwhile the whole electric traffic on the damaged section would be dislocated and would have to be handled by steam.

The erection of a third rail, no matter what system, will considerably interfere with the mechanism of the discs and rods at the cross-over roads and in goods yards, as well as with mechanical fogging arrangements.

The use of a third rail necessarily means the adoption of low pressures, and hence very large currents, which may amount to several thousands of ampères, have to be dealt with by each third rail conductor. Every gap in this conductor which would occur at level crossings and at all points and cross-over roads, which in the case of our suburban lines are exceedingly numerous, would involve the laying of very heavy "jumper cables" to connect the different sections of the third rail. These cables would not only add to the original cost of the work, but experience has shown that they are liable to give constant trouble and to be very costly to maintain.

Experience has also shown that where third rails are utilized, having

Digitized by Google

a high degree of conductivity, the material is such as to be liable to very rapid corrosion, and this is a point which at the present moment is considerably exercising the minds of many of the electric railway authorities in this country. Furthermore, experience particularly on the Metropolitan Railway, has shown that the wear of the third rail is a very considerable item. There are cases in London where the weight of a third rail, owing to the wear and tear and atmospheric and electric corrosion, has decreased 10 per cent. in four years.

The installation of a third rail, no matter on what system, makes it essential that the third rail and the permanent way should be looked after and maintained by the same staff. This has been thought by some to be an advantage; many experienced railway authorities think it to be the reverse, as it is certain to bring about complications between the electrical staff and the permanent-way staff of a railway, each of which in the ordinary course have their own particular duties to look after.

The above deals sufficiently with the disadvantages of the third rail, and all that need be said about the overhead conductor is that the disadvantages mentioned in connection with the third rail are entirely absent as regards the overhead conductor. The single-phase system has the additional advantage that it can be economically extended to long-distance lines, should this be found desirable in future.

Now to deal with the second point mentioned, viz., the first capital expenditure. We will first briefly deal with the comparative cost of the overhead construction and the third rail. In this connection it should be pointed out, that in the case of the Brighton Railway they are under obligations to the Board of Trade not to exceed a drop of 7 volts, if they use an insulated return continuous current system. Neither the Lancashire and Yorkshire nor the North Eastern Railway Companies are bound to such a clause, and the drops on these systems are considerably greater than anything that will be tolerated by the Board of Trade in the case of the L.B. & S.C. Railway. Under these circumstances the Brighton Company would have been forced to use two insulated rails, similar to the system adopted by the District Railway. In any case it would have been very unwise for them not to adopt such a system, as serious corrosion of pipes of all descriptions, cables, etc., might certainly be expected, particularly in a congested area such as London. Taking into consideration the fact of the very complicated nature of the points and crossings which must necessarily be encountered in a large suburban system such as that of the L.B. & S.C. Railway, it is evident that, notwithstanding the very strong and therefore expensive overhead system adopted, there can be but very little to choose between the cost of the overhead and the third rail systems, and it is quite possible that in the end this latter might prove the more expensive of the two.

Digitized by Google

In the continuous current third rail system, in addition to the power station plant, sub-station plant is required where the use of rotating machinery is essential. In order to convert the high tension alternating current supply from the power station into low pressure continuous current, continuous current converter plant has to be provided, and experience has shown that the amount of this sub-station plant, including storage batteries, amounts to from 125 per cent. to 200 per cent. of the power-house plant. Against this must be placed the fact that the single-phase equipments of the trains themselves are more expensive than the equivalent continuous current equipments, although the difference is relatively small.

Furthermore, in a large continuous current installation expensive low-tension feeders are essential. These will not be required where the high-pressure single-phase system is in use.

It is quite impossible without all the factors and local conditions to directly compare the cost of the continuous current and single-phase systems, but it can generally be shown that the single-phase system, when the whole installation is considered, from the power station down to the trains and line equipments, is considerably cheaper than the equivalent continuous current installation.

In connection with the last point, viz., the costs of operation and maintenance of the two systems, it must be pointed out that, as regards the question of costs of operation, whilst it is true that the amount of energy consumed at the train may be slightly greater in the single phase than in the continuous current system, this is more than balanced by the losses due to conversion from high tension alternating current to continuous current in the sub-stations, which takes place in the continuous current system. In addition to this the cost of current must necessarily be greater in the case of the continuous current system, owing to the capital charges and labour and maintenance charges involved.

The illustrations accompanying this article have been kindly lent me by the courtesy of *The Engineer* and *The Electrical Review*, as it was thought that they would give additional interest, as being typical of the subject discussed in the article. It will be noted that the illustrations represent the new trains designed by me, and constructed by the Metropolitan Amalgamated Carriage & Wagon Company, to be operated on the South London line of the L.B. & S.C. Railway.

An illustration is also given of the single-phase railway run at Spindlersfelde, equipped with Winter-Eichberg motors, and constructed by the Allgemeine Elektricitats Gesellschaft Company of Berlin. The illustrations also show the three-phase line belonging to the Italian Government, and equipped by the Ganz Company, which runs on the Valtellina line between Lecco and Sondrio, and third and fourth rail construction on the Metropolitan District Railway.

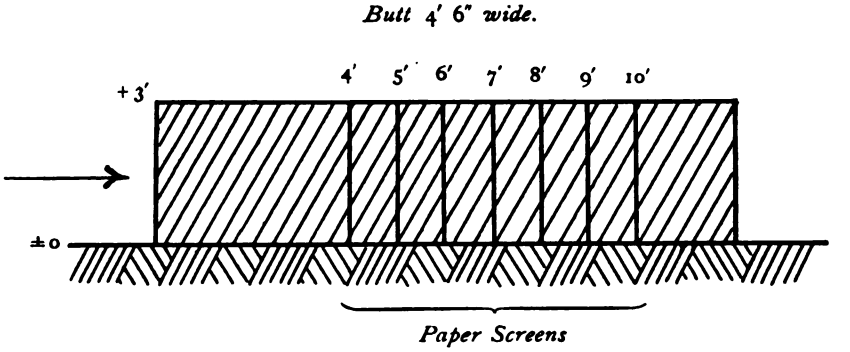
Digitized by Google

# *PENETRATION OF THE RIFLE BULLET INTO SNOW.*

*By* MAJOR J. C. MATHESON, R.E.

THE recent severe weather at Chatham brought with it a heavy fall of snow, and advantage was taken of this to try the penetration of the service rifle bullet into a snow parapet. Two butts of snow were made, one loosely thrown up, the other well consolidated by the men trampling it down.

*Longitudinal Section through Butt.*




The results of the trials are shown in the following tables, and may prove interesting.

*Unrammed Snow. Range, 33 Yards.*

| Round. | Penetration. | Remarks. |
|---|---|---|
| 1 | 9′ 2″ | |
| 2 | 9′ 4″ | |
| 3 | 9′ 11″ | |
| 4 | 7′ 0″ | |
| 5 | Through 7′ screen, not through 8′ one. | Not found. May have emerged from side of butt. |
| 6 | 9′ 6″ | Emerged from right of butt and found on ground 2′ away. |

Digitized by Google

*Rammed Snow. Range, 40 Yards.*

| Round. | Penetration. | Remarks. |
|---|---|---|
| 1 | 5′ 3″ | |
| 2 | 4′ 9″ | |
| 3 | 4′ 8″ | |
| 4 | 4′ 4″ | |
| 5 | 4′ 5″ | |
| 6 | Through 4′ screen, not through 5′ one. | Emerged from right of butt. Found on ground 8′ away. |
| 7 | ditto | Emerged from right of butt. Not found. |
| 8 | 6′ 0″ | Found lying at right angles to line of fire. |
| 9 | 5′ 7″ | |
| 10 | 5′ 1″ | Found lying at right angles to line of fire. |
| 11 | 4′ 9″ | ditto ditto ditto |
| 12 | Through 4′ screen, not through 5′ one. | Not found. |

The difference between the penetration into the unrammed and rammed snow, is very marked, the maximum in the former being just under 10′, and in the latter 6′.

In the case of the rammed snow the second six shots were fired into a different portion of the butt from the first six. There is a difference of 8″ in the average penetration. This may be accounted for by a difference in the degree of ramming.

None of the bullets were set up or deformed.

Digitized by Google

# *FRENCH AND ENGLISH METHODS IN FIELD TELEGRAPHY.**

*By* Major E. G. Godfrey-Faussett, R.E.

## Personnel.

The French regulations contemplate the connection of headquarters of armies to the various army corps, to the cavalry divisions, and to the line of communications. No provision is made for telegraphic communication inside the army corps, still less the infantry division. The units provided may therefore be suitably compared to our air-line and cable companies, whose duty it is to connect the headquarters of an army to our large divisions and to the line of communications. The special case of the cavalry division is provided for, with us, by wireless telegraphy.

One company of the 24th Battalion of the 5th Regiment of Engineers forms part of each army, and consequently serves three to four army corps. The company may therefore be compared conveniently with one air-line and one cable company of our organization, taken together.

The war strength of the French company is 10 officers and 293 N.C.O.'s and men, without drivers; whilst that of a pair of companies in our service is 12 officers and 293 N.C.O.'s and men, or oddly enough almost identically the same strength.

The French company is organized into a headquarters, 6 sections (each of 2 detachments), total, 12 detachments and a park. Ours have 2 headquarters and 7½ sections (each of 2 detachments), total, 15 detachments.

## Capabilities.

Miles of wire carried :—

French :—

| | |
|---|---|
| Field cable ... ... ... ... ... | 143 |
| Light cable ... ... ... ... ... | 35 |
| Bare wire ... ... ... ... ... | 124 |
| Total ... ... | 302 |

* Authorities :—*Instruction Pratique sur l'installation des Communications Electriques dans le service de la Telegraphie Militaire*, première partie; *Handbook of the French Army*, 1906; *Vade mecum de l'officier d'état major en campagne*, July, 1908.

Digitized by Google

English :—

| | |
|---|---|
| Cable ... ... ... ... ... | 90 |
| Air line ... ... ... ... ... | 60 |
| Total ... ... | 150 |

The French unit therefore carries just double the mileage of line, but this is largely accounted for by the company park; in our organization, spare cable and air line, of which 400 per cent. or 600 miles for the two companies is provided, is brought up by army transport as required.

As regards instruments, the French company carries no less than 96 sets; our pair of companies 45, with a reserve of 25 per cent., *i.e.*, 11.

For rate of construction the French regulations lay down that a greater pace than 2 to 3 kilomètres, say 2 miles an hour, must not be expected. This is about our pace for air line in easy country; cable in similar country would go twice as fast.

The rate of working is given at 400 words an hour. This is not an easy thing to compare, as it depends largely on the length of the messages; with us a single message of 400 words should be dealt with in 20 to 25 minutes; perhaps 500 to 600 words an hour would be a fair average rate when all was going well.

## MATÉRIEL.

The instrument in general use is what we should call a "Direct Recorder." There are two or three patterns, of much the same type as the "Instrument Morse Recording Set," which left our field units some 20 years ago. They also have "parleurs," or direct sounders, but apparently relay working is not used. No mention is made of duplex working or of any high-speed apparatus in the field regulations. The "voiture poste," or office wagon, is used, each section having one.

The "parleur telephonique" is comparable with our vibrator, but the buzzer forms part of a primary circuit, and the key is joined up similarly to that of a single-current set, bridge to line, front stop through the receivers to earth, back stop to secondary, and also to complete primary circuit. The buzzer has a small condenser in leak, and one of the receivers is a loud-sounding one to act as a call.

Batteries are of the Leclanché portable type—in the older pattern the solution is held in sponges, in the newer it is mixed with gelosine, a permanent vegetable substance.

Digitized by Google

An "Aubry" telephone is used for short lines. It consists only of a receiver, which is held alternately to ear and mouth. The 1899 Field Set has an Ader microphone, a mechanical vibrating call in the primary circuit, and two receivers.

*Lines.*—Chief reliance is placed on field cable, which is supported off the ground as much as possible—the shortest route is not chosen if supports exist along one not much longer. As a rule supports are not less than 45 yards apart, and the cable is not strained very tightly.

Light cable is used for temporary work. The bi-metallic wire is used for the repair of existing permanent lines. There is nothing answering to our air line.

*Vehicles.*—The wagons used are of four classes, all drawn by three horses driven from the box. The "working wagon" carries tools for a detachment and for repairing permanent lines. The "office wagon" is somewhat similar to our old office wagon, now surviving as a printing wagon. The "light wagon" carries men and kits, and the "pole wagon" 200 poles.

There is also a 2-wheeled cart for paying out cable, drawn by one horse.

The material is carried as in the following table :—

| | Morse Sets. | Parleurs. | Telephones. | Aubry Receivers. | Field Cable, miles. | Light Cable, miles. | Bare Wire, miles. | Poles. |
|---|---|---|---|---|---|---|---|---|
| 2 working wagons ... ... | 2 | — | 2 | 2 | — | — | 10 | 24 |
| 1 office wagon ... ... ... | 3 | 2 | 2 | — | — | $\frac{1}{3}$ | — | — |
| 2 light wagons ... ... ... | 4 | 4 | 4 | — | — | $2\frac{1}{2}$ | — | — |
| 1 paying-out cart ... ... ... | 1 | — | — | 1 | 3 | — | $1\frac{3}{4}$ | — |
| Total per section (2 detachments) | 10 | 6 | 8 | 3 | 3 | $2\frac{5}{6}$ | $11\frac{3}{4}$ | 24 |
| Company of 6 sections ... ... | 60 | 36 | 48 | 18 | 18 | 17 | $68\frac{1}{2}$ | 144 |
| Park—10 cable wagons ... ... | — | — | — | — | 125 | $18\frac{1}{2}$ | 50 | 500 |
| 3 pole wagons ... ... | — | — | — | — | — | — | $5\frac{1}{2}$ | 600 |
| Total per company ... ... | 60 | 36 | 48 | 18 | 143 | $35\frac{1}{2}$ | 124 | 1244 |

Digitized by Google

A *detachment* is organized as follows :—

| | |
|---|---|
| Officer in charge (responsible for route) ... ... | 1 |
| Sergeant (responsible for work) ... ... ... ... | 1 |
| Distributors (issue material, and keep check of amount used) ... ... ... ... ... ... ... | 2 |
| Payers out (one pays out cable, the other two guide it to the side, make joints, and make holes for poles) | 3 |
| Builders (first squad builds the line, working 100 yards in rear of wagon. Second squad strengthens it, working ¼ mile in rear) ... ... ... ... | 9 |
| Operators ... ... ... ... ... ... ... | 2 |
| Bicyclists (as orderlies and for breakdowns) ... ... | 2 |
| | 20 |

For working with light cable the normal detachment is as follows :—

| | |
|---|---|
| Sergeant (in charge) ... ... ... ... ... | 1 |
| Payers-out ... ... ... ... ... ... ... | 3 |
| Builders ... ... ... ... ... ... ... | 4 |
| Operators ... ... ... ... ... ... ... | 1 |
| | 9 |

In addition to the companies described above, there is a service of light telegraphs with the cavalry. Each of the two regiments of a cavalry brigade has a detachment of four men, one bicyclist and three on horses, and there is a 1-horse cart with each brigade.

New lines of more than 1,000 yards length are not contemplated as a rule ; the organization is intended primarily for the repair of existing lines. The material is normally carried in the cart, and consists of 2 Morse recorders, 2 "parleurs," 3 telephone sets, 2 Aubry telephones, 3,000 yards of light cable, and 10,000 yards of bi-metallic wire (bare). One telephone, 2,000 yards of wire, and the necessary tools can be carried in wallets by a detachment who work on foot.

To each cavalry division is attached a further detachment of six bicyclists, who carry tools and material for the destruction and repair of existing lines.

Digitized by Google

# *A PROPOSED TENSION BRIDGE.*

*By* CAPT. E. N. MOZLEY, R.E.

THE object of this article is to advocate the trial of a certain modification of tension bridge, in preference to the usual suspension type. The modification consists in the independent support of each road transom, by two pairs of straight ties from the tops of the two piers, as in the sketch below, where only three road transoms are shown.

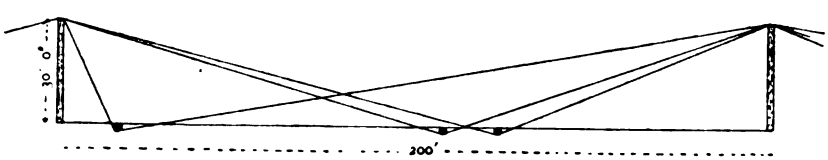



FIG. 1.

The advantages claimed for this method over the ordinary suspension bridge type are as follows :—

(1). Elimination of vertical oscillation through the omission of any curved tension members liable to distortion.

(2). Elimination of the liability of the bridge to collapse suddenly. This liability is always present in the suspension type in the event of the failure of a cable or cables on one side. It is true that if each side of the bridge is supported by several cables, the failure of one may not involve the remainder, but the tendency is to do so.

(3). No large cables are involved. This is a matter of importance, as they are rarely available on service.

(4). Distinct saving of time. If the comparison be between the two types, each making up its own tension members (on General Aylmer's principle), the type now advocated would save a lot of time—provided that as many men as necessary were available, which would probably be the case. For the suspension bridge will have more wires in a cable than a tension bridge in its thickest tie, and as the rate of straining each wire cannot be greatly increased by adding men, it follows that the ties for a tension bridge will be finished long before the cables of a suspension bridge.

There appears also to be a considerable saving of time during the actual erection of the bridge (compare the time-table given later on

Digitized by Google

with that given for a 200′ suspension bridge in Part III., *Military Engineering*).

(5). Simplicity and speed of adjustment. With the help of an overhead traveller, each transom can be adjusted by taking in its own ties at the anchorages.

(6). If only a few men are available for construction, a bridge of the type now advocated could be built, where the heavy work connected with the cables of a suspension bridge would be very difficult.

In comparison with the tension bridges, shown in Part III., Section 9, the advantages are :—

(1). Elimination of compression members, which, in the sizes there required, are not often to be had.

(2). Much larger possibilities of span.

(3). Very great saving of time.

(4). Greater simplicity of construction.

(5). The large working parties required for strutted tension bridges are not required.

The chief disadvantage of the proposed type, is that it usually requires about 30 per cent. more wire than a suspension bridge.

## CALCULATIONS.

The calculations are quite simple. The ties to each transom from the two piers are calculated in turn from the ordinary statical problem, shown in the sketch :—

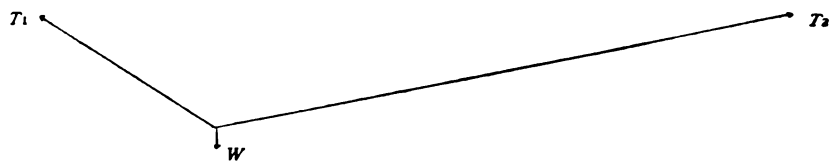



FIG. 2.

The frames, anchorages, etc., are calculated in the usual way.

## CONSTRUCTION OF TIES.

These are built by General Aylmer's method (*Professional Papers*, Vol. XX., 1894).

## CONSTRUCTION OF ANCHORAGES.

Two methods are possible. In the first all the ties are brought to the same anchor log, whose distance in rear of the frame must be calculated so as to bring a vertical pressure on the frame.

Digitized by Google

The alternative is to lead each tie to its own separate anchor log—or even to a picket holdfast—correctly placed with reference to the frame as before. This method might be very suitable if jumpers in rock had to be resorted to, or if the soil were very hard a short distance below the surface. It also provides against general anchorage failure.

## Frames.

These may of course be made in the usual way, but the following alternative is worth trying :—

Sheer legs, with a chain or strong wire lashing at the crutch, are substituted for a rectangular frame. The tips of the legs are capped, as shown, with a stout baulk overlapping the tips 6″ at each end.

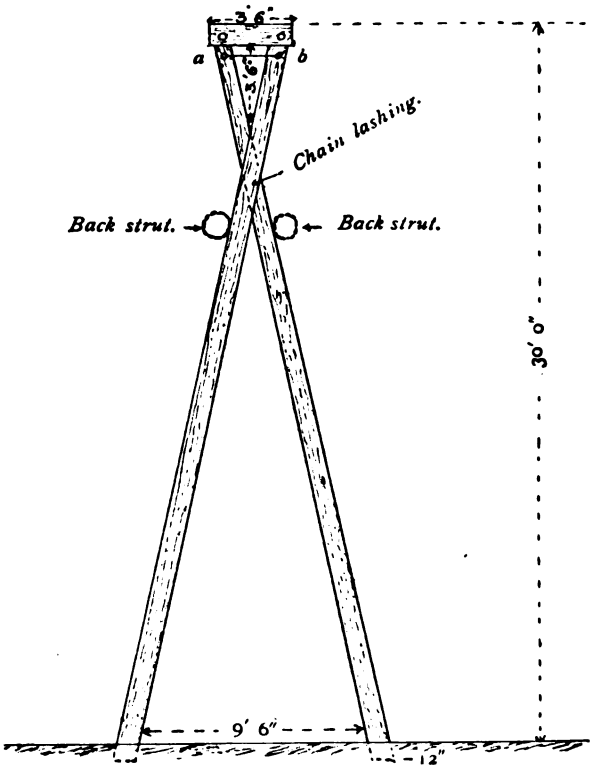



Fig. 3.

Auger holes may be bored through each leg 6″ from the tip, and through the cap where it rests on the leg. The cap is then prevented from shifting by wire lashings through the two pairs of auger holes respectively. Any tendency of the tips to splay outwards is

Digitized by Google

prevented by a wire lashing (*ab*) between them, well windlassed, and by subsequently nailing boards across above the crutch.

If a sheer leg frame is as efficient as the ordinary one, it is clearly to be preferred, as it needs only half the spars (5 instead of 10), much fewer fastenings, and is correspondingly easier and quicker to build.

Back struts and back guys would be used, but side struts would not be needed.

The butts of the legs should rest on small plank foundations.

Another advantage which sheers have over rectangular piers is that their feet can be more easily shifted, and that they can without danger be allowed to tilt a few degrees from the vertical, if undue stresses on back struts or guys call for it.*

## METHOD OF PLACING TIES AND TRANSOMS.

If possible, work should proceed from both ends at once.

We will consider the work at one end :—A man sits on the top of the sheers with a lashing to haul up the ties. The ends of the two ties carrying the first transom are sent up to the top of the sheers from the bridge side, and are passed by the man there down on the other side, and thence back to the anchorages, where they are temporarily made fast. The two ends on the far side are also lifted up over the far sheers and made fast temporarily at the far anchorage. Simultaneously the ties to the first transom on the far side should be lifted over the two sheers and temporarily made fast to the two anchorages. Enough slack should be left in the ties, to enable men standing at the pier to pull them down towards themselves—as in the sketch—and fix the transoms, or this may be done while the ties are being passed over the sheers.

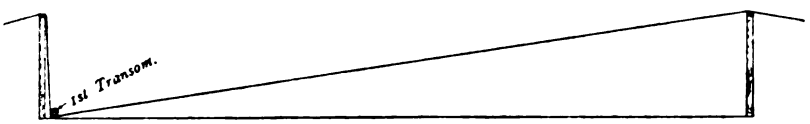



FIG. 4.

The transoms are best fixed to the ties by using stout wire, which is made fast to the tie close to the transom with several turns to prevent slipping, taken over the transom and made fast again to the tie on the other side in the same way.

* While the sheers are being erected, all the ties should be got across the gap and laid on each side of the central line in the order in which they will be needed.

Digitized by Google

As soon as the transom has thus been fixed, the four ends of the two ties supporting it are pulled in till the transom hangs in the right position, and are then permanently made fast. The roadway (except ribands) is next laid out to it. From 8 to 12 men are needed at each end of the bridge for placing ties and transoms. The above operation, including lifting the ties on to the sheers, fixing the transom, adjusting it, laying the roadway, and anchoring the ties, can be done in two hours if the ties have previously been got across. This estimate applies to 15′ bays. Therefore if both ends are being built out simultaneously, the bridge can be built at the rate of 15′ an hour. Twelve feet an hour would be a conservative estimate. The ties must be placed on the caps systematically. At one end the ties to transoms nearest the pier must be placed outwards from the centre, thus :—

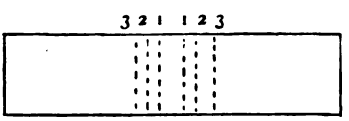



FIG. 5.

1—1, 2—2, 3—3, etc., representing the ties to the first, second, and third transom from that pier.

At the other end they must be placed inwards from the ends of the cap, thus :—

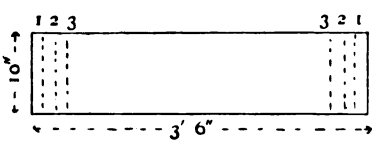



FIG. 6.

This will prevent ties crossing.

Ties must of course be placed in the same order at the anchorages.

The main work, and that which regulates the rate of construction, is the placing of ties and transoms. While this work is being pushed forward, other parties will be employed at the following jobs, working at both ends :—

Two parties, each of two men, ribanding down the roadway.

Two parties, each of four men with "treble and double" tackle, to adjust ties at the anchorages.

Two parties, each of four men, to fix straight horizontal wind-ties from points on the bank each side of the bridge to the ends of successive transoms.

Two parties, each of four men, to fix straight inclined ties under the bridge, so as to assist against vertical oscillation.

Digitized by Google

One party of four men, to place a traveller running between the crutches of the sheers.

This traveller is essential when the time comes to adjust the levels of the bridge after the roadway has been laid. It consists of a stout wire stretched as tightly as possible between the crutches of the sheers and made fast to the anchorages. A snatch block runs on this wire, and a "double and single" block and tackle hangs from the snatch block. It is perhaps better to have two such wires and two blocks and tackles. In that case the wires should pass over cross-pieces firmly lashed to the sheer legs, about 5′ below the crutch; the snatch blocks should be rigidly connected by a stick lashed to them.

Such a traveller takes four men about four hours to fix. When the level of any transom has to be altered, the traveller is run over it and the weight of the transom taken by the tackles. The ties to the transom can then be taken in or let out at the anchorages. The adjustment of the levels of the bridge after it has been completed should not take more than 15 minutes for every transom whose level has to be altered.

A few points may be added:—

Wire or chain must be used for ties. Cordage stretches so much as to be almost impossible to bring up to the requisite level.

Careful arrangement of ties is necessary; if once they get disorganized much time will be lost.

Nails may be driven into the caps to divide up the space for the ties, in order that they may not override each other, and a long spike into each end to prevent ties slipping off the cap as they are being placed.

If the cap extends sufficiently beyond the legs of the sheers, two men may sit on it, one at each end, and they can place the ties between them.

The height of piers should be as great as possible; this is more important for tension than for suspension bridges.

The ties can be got across the gap by stretching a line across from bank to bank, with a snatch block running along it, connected to each side by lead lines.

A draw vice, made fast to the main anchorage, and gripping the wires of a tie, will easily tighten the tie and even lift the transom to which it is attached.

The sheer legs should be braced together, and to the back struts, by frequent planking or spars.

The feet of the sheers must be so placed that the cap is at right angles to the axis of the bridge.

On one point this tension bridge is inferior to the suspension type. It requires from 25 per cent. to 35 per cent. more wire in its ties than the other does in its cables and slings together. This inequality

Digitized by Google

however only exists if each tie is made throughout of the same number of wires. It is evident that, except for the centre transom, this is uneconomical, as the portion going to the nearer pier takes a greater stress than does the other. If required, the ties may be made in two pieces (meeting at the transom), each of the necessary length and number of wires. This modification would not be at all necessary except for ties to the first two or three transoms at each end, as the remainder have an approximately equal tension in their two parts.

The following rates of work, tested with cadet labour, will be of interest :—

Four men can strain seven strands of No. 11 wire between holdfasts, 300′ apart, in one hour. This works out to about 500′ per man-hour ; but the rate varies, to a small extent, according to the distance between holdfasts.

The wire was always strained from one end, but was unrolled from both alternately.

One man can put on one binding of fine wire for a 7-wire cable in $1\frac{3}{4}$ minutes.

Twelve men, working in four parties, can place and tighten two new ties to any transom already in position in $1\frac{1}{2}$ hours.

A 200′ tension bridge, with 30′ sheer legs as piers, and 15′ bays, to carry infantry in fours, should be completed in the following time :—

| | |
|---|---|
| Construction of independent anchorages, one for each tie (60 men) ... ... ... ... | 4 hours. |
| Construction, erection, and staying of sheers (40 men) ... ... ... ... ... ... | |
| Getting all ties across gap (15 men) ... ... | |
| Placing ties and transoms, including traveller (28 men) ... ... ... ... ... ... | 17 hours. |
| Ribanding roadway (4 men) ... ... ... | |
| Fixing wind ties (8 men) ... ... ... ... | |
| Fixing ties below bridge (8 men) ... ... | |
| Adjusting bridge (16 men) ... ... ... | 2 hours. |
| Total ... ... | 23 hours. |

Finally, as an actual comparison between the rate of construction of tension and suspension bridges, the following facts and estimates are given :—

Exclusive of the time taken for making the ties, a 165′ tension bridge for infantry in single file was erected by cadets in *818 men-hours*. A suspension bridge for the same span and load was erected by cadets in *1,039 men-hours*.

Digitized by Google

Now the 200′ suspension bridge for infantry in file, described in Part III., is estimated to take 1,800 men-hours.

Comparing the 818 men-hours of the 165′ tension bridge with the 1,800 men-hours of the 200′ suspension bridge, we may assume :—

(1). That if sappers had been available the tension bridge would have been completed in two-thirds of the time, *i.e.*, in 545 men-hours.

(2). That if the tension bridge had been built to carry infantry in file it would have taken 30 per cent. more time, *i.e.*, $545 + 162 = 707$ men-hours.

(3). That, finally, if the span of the tension bridge had been 200′ it would have taken half as much time again as a 165′ bridge, *i.e.*, $707 + 354 = 1{,}061$ men-hours, as compared with the 1,800 men-hours estimated in the textbooks.

Digitized by Google

# *TERRITORIALS OF THE ROMAN IMPERIAL ARMY, 1ST CENTURY, A.D.*

*By* COLONEL O. E. RUCK, LATE R.E.

IN the January issue of the *R.E. Journal* some historical details were quoted regarding the ancient employment of Territorial troops by the Romans, Circa B.C. 100. Further research records much of the life history and progress of the movement.

By A.D. 100 the expansion of limits of Empire to far distant lands necessitated an increased number of men trained to arms to garrison and hold the same.

In B.C. 224, the year of the city 529 A.U.C., Italy alone supplied 50,000 cavalry and 700,000 infantry, strong and hardy peasants being eager to serve ;[1] but by the end of the 1st century A.D., the lands being now chiefly cultivated by slaves,[2] it was not quite so easy to raise recruits except by the use of the utmost rigour.[3] Frequently compulsion (*coercitio*) was requisite, and those who held back (*refractorii*) had to be forced to enlist under threat of corporal punishment (*damno et Vergis*).[4]

Somewhat more than a little coaxing had to be resorted to, many cutting off their thumbs, or fingers, to render themselves unfit for service ; hence the expression, "*pollice trunci*," *i.e.*, poltroons ; but this did not save them from punishment.[5] On one occasion Augustus put some of the most refractory to death ;[6] at other times they were fined, imprisoned, and sold as slaves.[7]

The first mercenary soldiers employed in the Roman Army are said to have been the Celtiberians, of Spain, A.U.C. 537, B.C. 216. In the Imperial Army however an increasing number of foreigners came gradually into the ranks. These were now composed to a large extent, both as regards the mercenary soldier as well as Territorials, of the poorer citizens, and it is reported that these causes were partly responsible for the decline in power of the Roman arms which developed after these changes in organization took place.[8]

No mild, emollient, or rose-water methods of attracting Territorial recruits appear to have been prevalent. A day was appointed on which all those male adults of suitable military age should be present

[1] Pliny, III., 20. [2] Livy, VI., 12. [3] Dio., LVI., 23. [4] Livy, IV., 53. [5] Suet., Aug. 24, Val. Max., VI. [6] Dio., LVI., 23. [7] Cic., Cœcin. 34. [8] Livy, II., 45.

Digitized by Google

in their various local centres.[1] On the day appointed the several consuls, seated in their curule chairs, held a levy (*delectum habebant*). With the assistance of the military tribunes they then determined, by lot, the order in which the tribes should be called up. Care was taken to select first those individuals who had lucky names (*bona nomina*), such as Valerius, Salvius, etc.[2] The nominal rolls thus prepared were written down on tablets; hence, *scribere*, to enlist, to levy, to raise.

It is only fair to mention that for certain wars, and under certain commanders, there was the greatest alacrity to enlist,[3] but this was not always the case.

To sweep up from the provinces those recalcitrant Territorials who, from one cause or another, failed to appear at the general levy, selected officials, called *conquisitores*, were sent forth to scour out the countrysides, being supported by a special purpose force termed *coercitio* or *conquisitio*, *i.e.*, a press or impress.[4]

When on the occasion of a sudden national emergency, or when a war in course of waging had rapidly developed into a more serious business than had been previously anticipated, a levy called *conjuratio* had occasionally to be made; the *conjurati*, or men thus raised, were, however, not considered on the same military footing as their more highly-trained comrades in arms.[5]

[1] Livy, XXVI., 31. [2] Cic., Dio. I., 45. [3] Livy, X., 25, XLII., 32.
[4] Livy, XXI., XXIII. [5] Livy, XLV., 2.

Digitized by Google

# *SWALLOW HOLES IN CHALK.*

*By* COLONEL W. PITT, LATE R.E.

(A brief abstract of this paper appeared in the *Journal of the Royal Geographical Society* for February, 1909.)

THE following notes refer particularly to an area in the north-eastern corner of Hampshire, lying between Alton and Basingstoke. I spent the latter part of the summer of 1908 in this neighbourhood. My attention was very soon attracted by the great number of swallow holes in every direction, and knowing little or nothing about their life history I sought for information on the subject. Fortunately there appeared in the *Geographical Journal* for September, 1908, two papers on the "Formation of Valleys in Porous Strata," one by Mr. F. J. Bennett and the other by the Rev. E. C. Spicer, and from these I learnt a good deal that I wanted to know. The following notes are intended to supplement the information given in the papers mentioned. Subsequently, endeavours have been made to learn more regarding swallow holes from the standard works on geology and elsewhere, but with singularly little success. This is rather remarkable considering that large areas of the country are riddled with these holes, which are sufficiently obvious to attract the attention of the most unobservant. Probably the information does exist, but I have not been fortunate enough to come across it.

Under these circumstances I propose to describe in some detail the swallow holes in the area referred to above, in the hope that the particulars given may be found useful by others more competent to deal with the subject than myself.

It will first be necessary to give a general description of this part of Hampshire. The area examined is covered by two of the Ordnance Survey 6-inch maps, Hampshire, Sheet XXVII. S.W. and Sheet XXVII. S.E. and therefore measures 6 miles from west to east, and 2 miles from north to south. The western half is occupied for the most part by a plateau from 500′ to 650′ above sea level, and the eastern half by a ridge running up to a maximum height of 740′. Towards the north-west the plateau runs off at about the same level in the direction of Herriard and Basingstoke. To the south-west it drops sharply into a valley, followed by the Alton and Basingstoke Light Railway. To the north and east the plateau and ridge slope away gently, but very steeply on the south and south-east, into the valley of the Wey. The formation of nearly the whole area is the upper chalk with flints, but in the south-east corner the steep scarps descend to the middle and lower chalk, and finally, just outside the area, we get down to the greensand of the Wey Valley at a level

Digitized by Google

of about 350′ above the sea. The dip is generally towards the north. The details given above are clearly illustrated on the 1-inch Geological Survey map, Sheet No. 284. This map shows a large portion of the area under consideration as being covered by "clay with flints and loam," and the margin of the clay is clearly defined. Now on comparing the boundary line of the clay with the contours some interesting facts will be noticed. In the first place, nowhere is there any clay shown below the level of the 500′ contour except two small patches in the south-east corner, and these are only just below 500′. And secondly, where it is on a spur the clay cap invariably runs over the point of it, and similarly the clay recedes from the head of a valley. These facts indicate that at one time the whole of the chalk was covered by a clay cap, possibly before it was raised to its present level, and that the absence of clay is due to denudation. It should however be pointed out that the distinction on the Geological Survey map between a covering of clay and no clay is somewhat arbitrary. In some places the cap is as much as 10′ thick, and dies out gradually to 2′ or 3′. Where the map shows no clay the soil is thin, sometimes only 1′ thick over the chalk, and consists of loam and flints. Frequently the surface is composed of little else but flints. It seems to be very difficult to mark out a line on the ground in such a manner that it may safely be said that there is clay on one side of it and not on the other. Probably on the whole the map is sufficiently accurate to justify the deduction drawn above.

The valleys are absolutely dry, I believe, at all times. There are no signs of any streams, and after long heavy rains I have not seen water running anywhere. Ponds are few and far between, and probably all artificial. The clay cap appears to be pervious everywhere. In fact, the water supply is a very troublesome matter in the neighbourhood. Most of the farms and other houses are dependent on rain water collected from their roofs. Some have wells, but owing to their great depth seldom use them. The obvious question is, where does all the rainfall go to? It is very difficult to answer this. A certain amount finds an outlet to the south at the junction of the lower chalk and greensand, and forms the source of the river Wey, about 2 miles to the south of the area under discussion. To the north there are two streams, the Loddon and the Whitewater, distant about 3 miles. Both have their source in the chalk, but as almost immediately afterwards it dips below the London clay, it is hardly likely that much of their water supply comes from the chalk. East and west there are no streams for many miles. The sum of the volumes of the three rivers mentioned amounts only to a very small fraction of the rainfall of the chalk area between them, and we are therefore driven to the conclusion that the bulk of the rainfall is absorbed in subterranean reservoirs below the saturation level of the chalk, and that the surplus finds an outlet at some considerable

Digitized by Google

distance. The country generally presents the normal characteristics of the chalk formation. There are the dry valleys, and the slopes generally are rounded and gentle, though in places narrow valleys with steep sides are to be found. I do not propose to enter into the vexed question of the manner in which these valleys were formed, whether by erosion due to the flow of water off the ice cap when it existed, or by subsidence caused by solution, further than to say that the present aspect of the valleys seems to me to indicate solution rather than erosion. Lord Avebury, in *The Scenery of England*, gives a diagram of a valley of erosion in chalk, which is a very flat U section. It is rather difficult to see how erosion can have caused it to assume this form; solution seems a more probable explanation. In one place only I noticed on a rather steep hillside signs of slipping, due apparently to subsidence caused by subterranean solution. Terraces in this part of Hampshire are conspicuous by their absence. I only discovered one, on the Alton Golf Links. It is well marked and about a quarter of a mile in length. It is not horizontal, but follows roughly the slope of the bottom of the valley on the side ot which it appears, approximately about 1 in 30. Incidentally I may remark that it is difficult to accept Scrope's theory* that terraces on the sides of chalk hills were formed artificially for purposes of cultivation. Vast areas of the mountain sides in the Riviera, Himalayan Valleys, and elsewhere have been terraced with this object, but in these localities there is little if any ground the slope of which is sufficiently flat to admit of tillage without terracing. The terraces on the slopes of chalk hills are found in close proximity to extensive flat or nearly flat downs, and it can hardly be imagined that at the time the terraces are supposed to have been made there was such a demand for arable land that an agricultural population was driven to increase its area by such an expenditure of labour as would have been necessary. Scrope gives an instance, also quoted by Lord Avebury, of a terrace which he actually saw formed by the plough, but I do not think this is sufficieut evidence to establish his theory. Similar terraces are to be found in limestone country, notably in the Isle ot Purbeck, where the labour required to form them would have been far greater than in a chalk district.

The area under consideration in this paper is heavily timbered. There are numerous woods, some of them of great extent. The timber is beech and oak, mostly the former, which grows to a large size. Apart from the woods the land is arable and pasture, the grass predominating. A remarkable feature of the district is the enormous size of the fields; many are from 80 to 100 acres in area. There is practically no unenclosed or common land remaining.

Having now described the nature of the country in some detail, I will come to the swallow holes. As already stated, the area under

* Scrope's "Terraces of the Chalk Downs," *Geol. Mag.*, Vol. III., 1866.

Digitized by Google

discussion measures 6 miles by 2, and is therefore 12 square miles in extent. On the 6-inch Ordnance Survey map there are marked within these limits 118 swallow holes. They are called on the map "old chalk pit." Literally this is correct; they are old, they are in chalk, and they are pits, but with few exceptions there is nothing to show that they have ever been used for the purpose of getting chalk. There are some obvious "chalk pits" in the ordinary sense of the term, but these are not included in the number given above. Chalk has undoubtedly been excavated from some of the swallow holes and used for building cottages and for dressing arable land where the clay cap is so stiff as to render this necessary.

It is quite easy to see where chalk has been taken out, because in every case where this has happened a cart road has been formed down the side of the hole. Without a road the chalk could only have been got out with the aid of a crane. The holes are all very much alike in appearance and dimensions; usually they are roughly circular or elliptical in plan, and the greater diameter is from 100′ to 200′. The depth seldom exceeds 30′. In section they are shaped like a crater with steep and sometimes nearly perpendicular sides, and a flat or slightly rounded bottom. Almost without exception they have trees growing in them, generally beeches, which are often of great age and size.

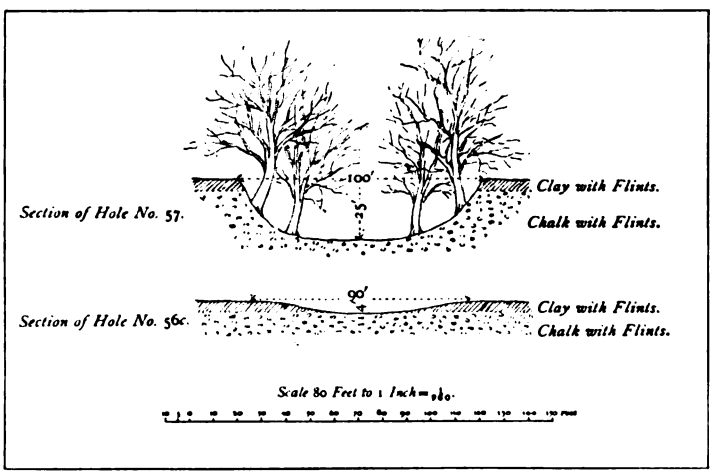
In the foregoing remarks reference has been restricted to those swallow holes which are indicated on the Ordnance Survey maps. In addition to these there is a considerable number of others which are of almost greater interest, being apparently in the early stages of their existence. Scattered about the fields there are numerous singular basin-like depressions. Unfortunately I was very much occupied with other work whilst in the neighbourhood, and was only able to plot and measure a few of them, which I have marked on the map. They differ from the mature swallow hole in having gentle rounded slopes instead of scarped sides, and have no trees or bushes growing in them. Often the depression is so slight as to be hardly noticeable, and where it occurs in a cornfield it can only be seen when the corn is cut. Below are the dimensions of those actually measured:—

| No. | Length. Feet. | Breadth. Feet. | Depth. Feet. |
|---|---|---|---|
| 48 *a.* | 62 | 62 | 2 |
| „ *b.* | 53 | 31 | 4 |
| „ *c.* | 51 | 36 | 1 |
| „ *d.* | 95 | 90 | 5 |
| 58 *a.* | 100 | 80 | 7 |
| „ *b.* | 100 | 80 | 5 |
| „ *c.* | 110 | 90 | 4 |
| 54 *a.** | 170 | 150 | 6′ 6″ |

* This hole is on sloping ground; the depth stated is the mean.

Digitized by Google

The accompanying sections show the two kinds of swallow holes. These shallow depressions bear a remarkable resemblance to dew ponds, except that they are quite dry. I have discovered no dew ponds in this part of the country. A suggestion presents itself that the dew ponds so common on chalk downs elsewhere are really immature swallow holes which have been puddled with clay so as to make them hold water. I am not competent to express an opinion as to whether this is the case or not, but offer the suggestion as worthy of consideration. It is a remarkable fact that there is no relation between the lateral dimensions of these shallow holes and their depth.




One would naturally expect to find some relation between the position of swallow holes and their surroundings, but with one exception I have failed to trace anything of the kind. They occur with equal frequency on level and on sloping ground, where the clay cap still exists, and where it does not. The exception however is rather remarkable, and it is this—that hardly any swallow holes are found in woods. Something like a third of the area I have examined is woodland, but of the 118 swallow holes marked on the map only three are actually in woods, though several more are to be found on their margins. Possibly some more of the shallow holes may exist in the woods hidden by the undergrowth; the mature ones could however hardly escape detection. The inference that suggests itself, assuming that the fact noted is not merely a coincidence, is that the woods now existing are of great age, and by keeping the rain off the ground have checked the formation of swallow holes by solution and consequent subsidence.*

* Since these notes were written I have, whilst shooting in the covers, noticed a few shallow holes.

Digitized by Google

None of the swallow holes examined exceed about 30′ in depth. In his paper referred to above the Rev. E. C. Spicer mentions that some of the holes in the chalk of the Chilterns are 80′ deep. It seems reasonable to suppose that there is a direct relation between the depth of the holes and the period of time during which they have been in course of formation. If then we could ascertain the rate of subsidence, we might possibly be able to fix approximately the date at which the chalk was raised to its present level, had nothing interfered with the progress of sinking. We must however bear in mind the glacial period and its resulting ice cap, beneath which there would be little if any solution and subsidence. The date arrived at might therefore be that of the disappearance of the ice. There are other possible modifying factors, such as a wide variation in the annual rainfall. It seems reasonable however to assume that, speaking generally, the depth of the holes varies as their age. If this is true the holes in the Chilterns are more than twice as old as those in the part of Hampshire under consideration.

The swallow holes described differ in many respects from those in the neighbourhood of West Malling and Maidstone, referred to by Mr. F. J. Bennett. The upland chalk in which they are found can never have been under the artesian conditions which he describes, and consequently upward hydrostatic action of water under pressure can have had nothing to do with their formation. There is no evidence of the existence of subterranean streams. In none of the dry valleys are there any bourne holes. Apparently therefore we must attribute the swallow holes entirely to the rain falling on the surface, soaking away more rapidly in certain spots owing to crevices in the 300′ or so of chalk down to saturation level, carrying with it chalk in solution and thus causing subsidence. The valleys may have been formed in the same way with the aid of a certain amount of erosion, due to water running over the edge of the ice cap on the summits. There is no connection apparent between the swallow holes and the valleys, except possibly in one case, where the holes, numbered 12, 13, 4, 5, 6, 7, and 8 on the accompanying map, certainly do follow more or less, in the order given, the line of the bottom of a valley. On the other hand, there is a ring of 11 holes, all actually on or very close to the 700′ contour line. I should however be sorry to suggest that there is anything in this beyond a mere coincidence.

I have assumed in the foregoing remarks that the solution theory is sound. It would seem however that the evidence in support of it, to be derived from a study of the swallow holes and valleys in the particular district described, is not conclusive. I have no alternative theory to put forward, and would suggest that much valuable information might be gained by trenching a section across a typical hole and carrying it down into the chalk to some depth below the bottom.

Digitized by Google

# *THE R.E. HEADQUARTER MESS.*

(*Continued*).

*By* Lieut.-Colonel B. R. Ward, R.E.

In addition to the portraits and busts already described, there are various pictures and curios in the Mess, reminiscent of campaigns or of distinguished officers of the Corps extending over a period of 130 years.

Our oldest pictures consist of a couple of water-colour sketches by Capt. William Booth, R.E., executed in 1778 and 1785 respectively. These sketches—the only contemporary relics we possess of the period of the American Revolutionary War—represent the camp of Hardenberg's Regiment of Hanoverians in 1778, and a view of Point Carleton, near Shelburne, in Nova Scotia, taken on the spot in 1785. Hardenberg's Regiment of Hanoverians appear to have been at Minorca in 1778.

The occasion of the second sketch was a tour of inspection in Nova Scotia undertaken by Lieut.-General Archibald Campbell* in 1785, to inspect a site on which it had been decided to form a settlement of United Empire Loyalists—the term given to those inhabitants of the United States who remained loyal to the crown.

It has been estimated that about 40,000 of these Loyalists migrated to Canada within a few years of the second Treaty of Paris in 1783, and over 10,000 of them were settled at Shelburne.

A portrait of Capt. W. H. Robinson, R.E., one of the first of the Canadian cadets from Kingston to be commissioned in the British Service, is hanging in the same room as the Shelburne sketch. Capt. Robinson, who was born in St. John, New Brunswick, in 1863, and who came of United Empire Loyalist stock, was killed while leading an assault on a West African stockade in 1892. A brass has been placed in Rochester Cathedral to commemorate this officer—the first Kingston cadet in the Imperial Service to be killed in action.

Two engravings of pictures by J. S. Copley, hanging in the entrance hall, commemorate incidents in the Siege of Gibraltar, which formed such a prominent incident in the American Revolutionary War.

* Porter's *History of the Corps*, Vol. II., p. 397.

Digitized by Google

One of these represents the combined attack by the French and Spanish fleets on the Line Wall defences, and is entitled "The Siege and Relief of Gibraltar." The other illustrates the sortie made by the garrison on the 27th November, 1781.

The Napoleonic wars are commemorated by the bust of Vauban, already described, and also by a copy of the now rare engraving of the Waterloo Banquet at Apsley House on the 18th June, 1836. The Duke is supported on his right by King William IV., and on his left by the Prince of Orange,* who commanded the 1st Corps of the allied army on the 18th June, 1815. He is represented standing under a portrait of Charles I., by Vandyke, directly facing him being the silver centrepiece presented by the Government of Portugal, the table being flanked by two magnificent candelabra presented by the Emperor of Russia.

The engraving was presented by the N.C.O.'s Mess at Chatham in 1888.

Another picture commemorative of the Napoleonic epoch is an engraving dated 1819 of the picture by J. Isabey of the Congress of Vienna. The Congress sat during the years 1814 and 1815, until it was dramatically brought to a close, or rather interrupted, by Napoleon's return from Elba, and the Hundred Days.

The Crimean War is portrayed by a series of 12 large water-colour sketches by J. Ferguson, from the original drawings by Major Michael Bidduph, R.A.

An elaborately carved inkstand, presented to the Mess by Sir Andrew Clarke, recalls the second Sikh War of 1848–49. A copper scroll on it bears the following inscription :—"This zinc shell, fired by the Sikhs, was picked up during the action on the battlefield of Goojerat by Lieut. Henley Maxwell, Bengal Engineers. The wood came from a Sikh gun-carriage. The whole designed into this ink-stand by that officer, the workmanship being executed by his native sappers."

The sack of the Summer Palace at Pekin in 1860 is represented by three articles, a beautiful square of embroidered silk about 2′ 6″ × 3′ mounted under glass, and presented by Lieut. J. Curling, R.E., in 1873, and a small Dutch or French oil painting representing a lady bargaining in a fishmonger's shop. Both of the foregoing were originally obtained by Lieut. (now General Sir) R. Harrison, R.E.

The third article is the magnificent carved throne now standing under the portrait of the King in the Mess Room. This we owe to Chinese Gordon, who at the time commanded the 8th Company, R.E., which was attached to Sir John Michell's Division in China in 1860.

To Sir John Michell was entrusted the duty of burning the

* Afterwards King William II. of Holland.

Digitized by Google

Emperor's Summer Palace at Pekin. During that operation the troops were allowed to keep such articles as they could rescue from the flames. Gordon took the throne from the throne room, had it packed up, and confided it to the care of the first company, R.E., going home, to present to the Mess of the Corps. The first to come home was the 23rd Company, then commanded by Major (afterwards Sir) G. Graham (with Pritchard and Harrison as subalterns). The woodwork only was brought home. The cushions were added by the Mess.

The Zulu War of 1879 is commemorated by an artist's proof of De Neuville's fine picture "Rorke's Drift"; and the second Ashanti expedition is represented by a royal stool taken from King Prempeh's house at Kumasi in 1896. It was presented to the Mess by the R.E. officers of the expeditionary force.

The stool is the symbol of royalty among the Ashantis, the Golden Stool representing to them the Ashanti power. King Prempeh was incarcerated as a political prisoner in 1896; but as the Ashantis still had possession of the Golden Stool, the removal of the King had not the same effect on their minds that the loss of the Stool would have produced. The rebellion of the Ashantis in 1900 may indeed primarily be traced to the search for the Golden Stool which was inaugurated that year by the Governor of the Gold Coast. In the absence of the Golden Stool—for to this day its hiding place is unknown—the wooden stool in the Mess may symbolize British rule over the Ashanti territory.

A suit of Dervish chain-mail armour, spears, and other trophies sent from Omdurman by Lord Kitchener in 1898 recall the end of the operations in Egypt, which commenced with the bombardment of Alexandria in 1882.

Three South African mementoes are kept in the small room adjoining the S.M.E. Library. One is a large two-handled brass measure, inscribed :—

IMPERIAL BUSHEL
GOVT. OF THE TRANSVAAL
1889.

The second is a Boer Artillery busby taken at Pretoria and presented by Lieut. C. H. Ley in 1901, and the third is the Orange Free State flag—the Vierkleur—that was flying over the Town Hall at Bloemfontein when the British troops marched in on the 13th March, 1900. This trophy was presented by Major W. A. J. O'Meara, C.M.G.

Over the fireplaces in the entrance hall hang two interesting examples of Japanese cut-velvet pictures. These were presented to the Mess by Major K. Miyabara, of the Imperial Japanese Engineers, who was stationed at Chatham for a course of Military Engineering in 1903–04, and again from 1906–08. Recalled early in 1904 on

Digitized by Google

account of the Russo-Japanese War, he served throughout the Siege of Port Arthur as adjutant to the Chief Engineer at the headquarters of General Nogi, being awarded the 4th Order of the Rising Sun and the 5th Order of the Golden Kite for his services during the siege.

Many of the officers whose portraits and busts have been already described are also represented by means of engravings. Thus a portrait of Lord Napier of Magdala hangs in the entrance hall, one of Sir William Denison upstairs, and the small ante-room contains an engraving of the statue of Sir John Jones in St. Paul's Cathedral, as well as portraits of Burgoyne, Drummond, Sir Lintorn Simmons, and Sir John Bateman-Champain.

In addition to those officers commemorated by portraits in oils, engraved portraits of the following are hanging in the Mess:—

Colonel Colin Mackenzie, C.B., F.R.S. (1753–1821), of the Madras Engineers, a famous Indian surveyor and antiquary (*Dictionary of National Biography*, Vol. XXV., p. 138).

Major-General Sir James Carmichael Smyth, Bart., C.B., K.C.H. (1779–1838), C.R.E. at Waterloo (*D.N.B.*, Vol. LIII., p. 185).

Colonel A. W. Durnford, killed while covering the retreat at Isandlwana on the 22nd January, 1879 (*D.N.B.*, Vol. XVI., p. 264).

Lieut. Thomas Rice Henn, killed while in command of a party of Bombay Sappers covering the retreat at Maiwand on the 27th July, 1879 (*D.N.B.*, Vol. XXV., p. 422).

Capt. W. J. Gill, killed in the Sinai Desert on the 11th August, 1882 (*D.N.B.*, Vol. XXI., p. 355).

Major-General H. Y. D. Scott, C.B., F.R.S. (1822–1883), the architect of the Albert Hall (*D.N.B.*, Vol. LI., p. 26).

Colonel C. E. Harvey (1833–1885), a well-known figure at Chatham, where at the time of his death he held the appointment of Assistant Commandant (*R.E. Journal*, 1885, p. 111).

Major-General Sir Edward W. Ward, K.C.M.G. (1823–1890), Master of the Mint at Sydney.

Herr J. H. Sawerthal, Bandmaster, R.E. Band (1819–1893), (*R.E. Journal*, 1893, p. 133).

General Sir Wilbraham O. Lennox, V.C., K.C.B. (1830–1897), (*D.N.B.* Suppt., Vol. III., p. 92).

Major-General Sir W. Crossman, K.C.M.G. (1830–1901), (*R.E. Journal*, 1901, p. 185).

And, lastly, a portrait of General Todleben, the famous defender of Sebastopol and director of the attack on Plevna.

Digitized by Google

# *MEMOIR.*

## *THE LATE COLONEL JOHN ROBERTS HOGG, R.E.*

*By* 'A.T.S.'

JOHN ROBERTS HOGG was born in London, 1838, his father, John Hogg, M.D., being a physician practising there. He obtained his commission in the Royal Engineers on the 1st October, 1857.

In December, 1860, he went to Corfu, and during the latter part of his service there was engaged in the demolition of the fortifications in connection with the transfer of the Ionian Islands to the Kingdom of Greece. He returned home in June, 1864.

Soon after this Hogg was sent to Chatham, where he was engaged in some interesting work on one or two of the Medway forts, which had been recently built on a thick bed of concrete laid in the mud without piles. The unequal weights of the superstructure and armament caused the foundation bed to sink unequally, dipping towards the river front, and it was decided to remedy this by equalizing the weight as far as possible. Hogg carried out this work ably, and with as much success as the circumstances admitted of.

He was next sent to Devonport in 1866, and remained there for over four and a-half years. After a tour of foreign service he went to Chatham again in 1878, remaining there for over five years. Here, as well as during his previous service at Devonport, he distinguished himself by his ability and energy in carrying out important work on the fortifications then under construction.

Of his services at these stations Colonel R. H. Vetch, C.B., R.E., writes: "I was stationed with Hogg at Plymouth in 1868; he was then employed under Capt. Ponsonby Cox on the land defences. Hogg took great interest in his work and was most indefatigable. The contractors had failed, and Capt. Cox had asked to be allowed to carry on the work himself without any contractors. It was a big job, comprising all the forts from the Tamar to Crown Hill. Cox had some difficulty in persuading the authorities to agree to his proposal, but with the support of Colonel Cunliffe Owen, the C.R.E., he ultimately succeeded, and permission was given.

"Of course the work thrown upon Cox and his officers, J. R. Hogg and A. G. Clayton, was enormously increased and was very onerous. The provision of labour and the purchase of materials and stores, and everything in the nature of plant and workshops, had to be arranged for by the officers, while the innumerable checks which the finance

Digitized by Google

branch of the War Office and the Treasury devised for the safety of the public purse entailed a vast amount of clerical work and accounts. Capt. Cox was as proud of his officers as they were of him when the result showed that considerable savings were being made on the estimates for contract work, while at the same time the work was being much better done.

"Ten years passed before I was again quartered in the same garrison as Hogg. It was probably the record of his work at Plymouth that led the authorities to send Hogg to the Chatham district to supervise the construction of the Chatham land defences, which were being executed by convict labour. Again he was absorbed in his work, but the slow rate of progress made by the convicts and the small amount of money provided annually took the heart out of the work and fretted him a good deal. He must have compared the work at Chatham very unfavourably with that which he helped to do at Plymouth."

Hogg was promoted Lieut.-Colonel 1883, and was sent to Portsmouth as Sub-District C.R.E., being placed on half-pay in 1888. While on half-pay he was employed by Sir John Pender on a mission to North America, to make enquiries as to the prospects of certain projected railways in Texas and Mexico, and to examine the country through which they were to run. This was a task requiring no little tact and discernment, but Hogg acquitted himself of it to Sir John Pender's entire satisfaction.

In 1889 he was appointed Colonel on the Staff and C.R.E. at Malta, remaining there for five years. During this period extensive works were in progress under the Imperial Defence Act in the re-modelling and re-armament of the defences. The fine new barracks at Imtalfa were also designed and built, and much other work was in progress. On leaving Malta he was for a time on half-pay, and retired in November, 1895.

Hogg was particularly well acquainted with, and deeply interested in, the subject of fortification, as being, together with engineering work generally, the branches of his profession to which his talents were chiefly directed, and he had carefully studied the problems and practice of fortification both at home and abroad. He was a successful amateur photographer, and left a collection of beautiful photographs of places he had visited. Personally, he was a man of a somewhat quaint and original character, extremely reserved and retiring, but kind and considerate, simple and straightforward, a staunch and loyal friend and comrade. He married late in life and leaves a widow to mourn his loss. His later years were unhappily clouded by a distressing malady, which he bore with unfailing patience and gentleness. He died at Ealing on the 27th November, 1908. R.I.P.

The writer desires to thank the numerous officers who have kindly furnished him with information and assistance.

Digitized by Google

# *TRANSCRIPTS.*

## FIELD KITCHENS IN THE GERMAN ARMY.

*By* COLONEL E. HARTMANN.

(Reproduced by kind permission of the Author and Messrs. Mittler).

### PREFACE.*

IN proportion as the fighting strength of our modern armies has been increased, the difficulties of provisioning them have likewise been enhanced, and one of the first questions to be considered is how to provide the men with food. For though the commissariat, with its assistant branches of the Service, may and does overcome these difficulties by procuring the various kinds of food at the proper time and in the proper place, further difficulties not infrequently arise among the troops owing to the fact that the raw food-stuffs supplied by the commissariat have still to be prepared and converted into palatable and nutritious dishes.

This work of preparing the dishes is, among all armies, left to the men, and the cooking is done either individually or collectively by the aid of a common cooking appliance, on which the food is prepared and cooked for a whole section or squad, as is mainly the case among the mounted troops.

This mode of procedure however generally possesses this great drawback, that the men when at rest are often obliged to wait an exceedingly long while until they obtain their meal, for the provisions must first be obtained and distributed before the actual cooking can be done, with the frequent result, both in times of peace as of war, that it is not until long after sunset when the men—thoroughly fatigued and hungry with the exertions of a long day's march after a skirmish or a battle—have a chance of getting a meal, and this not infrequently one of a rather questionable character.

Thus it came to be recognized as an indisputable fact that the task of nourishing the troops, and thereby essentially promoting their fighting capacity, is materially facilitated when the single trooper can obtain his meal, ready cooked and prepared, from a field kitchen, and need no longer go to the trouble of preparing it himself.

For little doubt exists that if in the wars of the past the strength of an army was already considerably diminished in consequence of sickness and disease after the very first marches, it may principally be ascribed to the character of the food which the men prepared for themselves. Were this drawback to be removed for the future, it would be beyond a question that the various divisions of an army would be enabled to take part in the very first engagements of a decisive character in a far greater numerical strength than is at present generally assumed.

To introduce a reform in this direction has thus become a matter of

* Based on official material, with the permission of the Royal Minister of War.

Digitized by Google

imperative necessity, and after specially constructed and transportable field kitchens had been tried among various armies, their absolute and complete practicability was clearly demonstrated during the Russian-Japanese War, when it was particularly the transportable field kitchens, in which the food was cooked and prepared during a march or in the course of a battle, that gave the most satisfactory results. By means of these the men could be provided with a good hot meal after a long march, immediately on reaching their point of destination, or even in the very midst of an engagement.

The German Regulations for the Field Service of October 22nd, 1908, Section 6, run as follows:—

"It is the noble and grateful privilege of the officer to devote his unceasing care to the welfare of his men. All commanding officers must strive to constantly maintain among their men a love of duty, since it offers the very best security for the successful accomplishment of their work."

This love of duty however—it is a fact beyond a doubt—is increased by nothing so much as good food. For it is a well-known axiom among the men that the stomach is the source of all courage, and that a hungry soldier is good for very little, since his fighting capacity is naturally diminished by poor or insufficient nourishment. Hence the officer's care must for the main part concentrate its attention upon the food question.

Again, since the tactics of war have undergone a change, it stands to reason that likewise the requirements of the various divisions of an army have to be adapted to the new conditions, both as regards the individual responsibility of each combatant and his requirements in the way of nourishment. As a result of these considerations the Military Administration finally deemed it advisable to introduce field kitchens.

### 1ST PUBLIC COMPETITION.

In order to obtain a field kitchen which in its form and construction would prove suitable to German conditions, the Royal Prussian Ministry for War in the October of 1905 submitted the question of constructing a system of transportable field kitchens for the Army to a public competition, subject to the following conditions:—

1. The field kitchen, while constructed of an adequately strong and durable material, must yet be light enough to permit it, even when charged, to be drawn if need be by a small horse, either along soft ground or across a rugged tract of land in the wake of infantry. The gauge to be 1,530 mms. from tyre to tyre.
2. The copper must be capable of containing 150 litres.
3. The field kitchen must be arranged in such a manner as to allow of the food being prepared and cooked while the vehicle is in motion.
4. It must be possible to cook all varieties of field fare in the field kitchen, in particular vegetables; at the same time any danger of the food being burned must be absolutely excluded.
5. There must be no difficulty in the way of cleaning the copper.
6. It must be possible to heat the field kitchen with all kinds of available fuel, such as wood, peat, coals, straw, etc.

Digitized by Google

7. No special box is required for the driver; however, there must be room to store the man's baggage (15 kgs.) and also a box of 0·25 cbm. space for the supply of oats (18 kgs.) for the draught animal.
8. The vehicle must be fitted out with a very simply constructed but absolutely reliable brake appliance.

Of the great number of models of field kitchens—about 40—which were submitted as a consequence, but a small proportion adequately complied with the required conditions, and were admitted to a closer test. Of these again but two seemed to come up to the actual requirements, possessing distinct advantages both as regards the construction of the vehicle and also the cooking arrangements.

Meanwhile the suggestion had been offered to the effect that the weight of the baggage carried by the infantry might be reduced by storing a certain amount of the provisions, ordinarily carried by the men, in the field kitchens. However, this could only be realized if the kitchen were fitted on to a double two-horse vehicle, to either of the two parts of which one of the two horses could be harnessed, each part being capable of being used independently of the other, instead of being, as originally planned, fitted to a single-horse, two-wheeled cart, transportable if need were by human beings.

### 2nd Public Competition.

In the August of 1906 therefore the Military Administration decided to submit the question of procuring a transportable field kitchen for the Army to a second and more limited competition, those firms being particularly invited to take part whose models at the first competition had shown distinct advantages over those of their fellow competitors with regard to both arrangement and construction, the following being the special conditions to which the competition was subjected:—

1. The field kitchen must be constructed as a four-wheeled, two-horse vehicle, the hind carriage of which must be easily detachable from the fore carriage, and when detached it must be possible to put a horse to each, and to employ either or both parts independently.

The hind carriage must be capable of containing—

| | | Weight of about |
|---|---|---|
| Each stored in a separate chamber | Kitchen utensils .. ... ... | 5 kgs. |
| | Two extra rations (for the horses) in a feed-bag ... ... ... | 12 kgs. |
| | Fuel (light firewood) for 1 day ... | 20 kgs. |
| 200 extra allowances (for the men) in a separate chamber ... ... ... ... ... ... | | 160 kgs. |
| If possible together in a separate chamber | Four extra rations (for the horses) in a feed-bag ... ... ... | 24 kgs. |
| | Driver's baggage ... ... ... | 15 kgs. |
| | Spare stores ... ... ... | 14 kgs. |

The separate chambers must be provided with lock and key.

The aforementioned rations and allowances have been considered on the average.

Digitized by Google

2. The total weight of the fully charged and equipped field kitchen, exclusive of the men (its durability being in nowise impaired), must not exceed 1,100 kgs.

   The kitchen, drawn by two horses, must be capable of following in the wake of infantry along both soft or rugged ground, and at a trot along good roads.

   The proportion in weight between the fore and the hind carriage must be approximately 2:5; the hind carriage however, when fully charged and equipped, must not weigh more than 700 kgs.

3. The gauge (from tyre to tyre) is to be 1,530 mms. The distance of the greatest depth of the ground from either fore or hind carriage to be at the very least 400 mms.; notwithstanding, the centre of gravity must be sufficiently low as to remove as far as possible any danger of the vehicle being upset on a rough road.

   The hind carriage or the copper is to be on springs.

   In the selection of the wheel, reference is to be had to wheel-type n/K of Ambulance Carriage 95. In the same way, the shaft, pintail, and trace are to be adapted in their construction, as far as possible, to type 95 n/K.

4. The vehicle must be fitted out with a reliable brake contrivance acting on the hind wheels, and, if possible, manageable from the driver's box.

5. The vehicle must possess a seating accommodation for both the driver and cook.

6. The copper is to be made of nickel, preferably stamped, and capable of holding 150 litres, and must possess moreover a broad brim.

7. The field kitchen must offer the possibility of cooking all varieties of field fare, particularly vegetables; any danger of the food being burned to be absolutely excluded. This last to be obtained by making use of a bath of glycerine or other fluid of the like properties, especially as to the vaporization and freezing points.

8. The copper must present no difficulties in the way of a quick and easy distribution of the food; nor must there be any difficulties with regard to its being cleaned. (It is however not desired that it should possess a waste tap).

9. The lid, which must close absolutely tightly, as well as the parts protruding beyond the rim, are, if possible, to be isolated for the better retention of the heat.

   It must be fitted out with ample safety appliances, such as valves, manometer, an instrument to record the state of the fuel, etc. Provision must also be made to prevent the valves from being stuffed up by remnants of food.

10. The introduction and utilization of bright shining parts, that would be visible from afar, are to be avoided; as also care must be taken to prevent the various parts of the vehicle from creating too great a noise when the vehicle is in motion.

Digitized by Google

11. Should the general weight permit of it, it would be deemed advisable if the following improvements could still further be introduced :—

(*a*). The possibility of heating or boiling 70 litres of water, for the purpose of preparing tea, coffee, etc., in one or several vessels. Care must be taken to prevent this extra supply of water from evaporating too quickly.

The weight of this vessel, or these vessels, including contents, must be contained in the total weight of the kitchen, viz., 1,100 kgs.

(*b*). An increase in the size of the boiler, making it possible of holding 200 litres instead of 150.

(*c*). In either fore or hind carriage an additional chamber for the storing of further provisions.

If the conditions of this second competition have been thus detailed, it has been for the sole purpose because, firstly, this having been a limited competition, they were only submitted to those firms who at the first competition had given proof of their capability by submitting models of an acceptable construction and arrangement; secondly, because they show to what extent the experience gained during the first competition had already been made use of.

## General Survey.

It can be no part of this article to enter into a full and detailed examination of the various models of field kitchens which were submitted as the result of this competition.

Only a small number complied with the required conditions. They may be divided into three groups, viz. :—

1. Solid-framed vehicles, fore carriage not detachable from hind carriage.
2. Fore carriage detachable from hind carriage, but the former alone to be practically utilized.
3. Fore carriage detachable from hind carriage, each practically capable of having a horse put to it, and thus being employed independently of the other.

The first two may be passed over at once as far as their practical utility is concerned; of the third group, but two models approximately complied with the required conditions.

At the same time it may be noted that the consumption of fuel among many of the models submitted was an exceptionally large one.

Among the vehicles submitted for the closer competition of April, 1907, there was also a Russian model, the copper of which, as in several other field kitchens, was suspended in a steam bath as a means of preventing the food from being burned. This contrivance however did not prove practicable :—

(*a*). Because the weight of the kitchen was unnecessarily increased by the quantity of steam required.

(*b*). Because the steam bath evaporated during the cooking process and constantly required to be renewed.

Digitized by Google

(*c*). Because the steam bath froze in cold weather, the kitchen not being in use, and thus burst the sides of the copper.

(*d*). Because the constant refilling of water caused the settling of fur, thus impairing the cooking process, and which fur, if not removed from time to time, gradually rendered the kitchen useless.

(*e*). Because, in spite of manometer and valves, the constant danger of an explosion is coupled to steam.

(*f*). Because the kitchen could not be employed as a self-cooking apparatus.

Among the other kitchens sent in for competition, various kinds of boiling fluids were employed for the purposes of the bath, all of which were retained in the further experiments.

The under frame of the vehicles was partially a fixed and partially a balancing one. The former system made it difficult for the kitchen to turn the corners of narrow roads; the latter tended to impede the speed of the vehicle. Kitchens constructed since have been fitted out with a system of limbering on springs, which, while avoiding the drawbacks, united the advantages of the two other systems.

The vehicle is composed of a fore and a hind carriage. Attached to the hind carriage is the light frame, made of pressed sheet-steel girders or supports fitted to the axletree by means of plate springs. The extremely reliable brake is served from the rear. On the fore carriage is a fairly large-sized limber box, which, while not on springs, forms the seating accommodation for the driver and the cook. This part of the vehicle is likewise supplied with a brake. Both carriages are joined to each other by a system of coupling, which possesses the following noteworthy advantages:—

1. The fore carriage may be detached from or attached to the hind carriage in the shortest space of time possible.
2. The presence of an ample locking angle permitting the vehicle to turn within even a very narrow road.
3. The possibility of employing a large limber box without impairing the motion of the vehicle.
4. Avoiding any danger of the shaft striking the horses, since its pressure upon the animals is relieved by the peculiar spring contrivance of the coupling.

A second shaft which when not in use is stored beneath the vehicle, and which makes it possible to drive both the fore as the hind carriage singly and independently of the other. A set of supports, suspended to the frame, and which can be easily set up, allow of the carriages being firmly fixed to a spot when detached and not in motion.

It is further worth noting that the vehicle may be driven with complete ease across hills and ditches, at right angles or in an oblique direction, without unnecessarily taxing the strength of the horses, both fore as hind carriage adapting themselves to the nature of the road, be this ever so rugged and steep.

In consequence of the stereotype plates having been kindly placed at my disposal by the manufacturers of the cooking contrivance, *The Economiser Cooking Stove Works of A. Senking* at Hildesheim, I am enabled to

Digitized by Google

reproduce the field kitchen (Views 1—4) as finally constructed, the result of repeated trials and improvements, and in the form now actually introduced.

Though mindful of the importance which attaches to the form and shape of the vehicle proper, it is after all the kitchen, that is to say the cooking contrivance, which is of main importance.

The cooking contrivance, fitted to the hind carriage of the vehicle, consists of a copper capable of holding 200 litres and another smaller copper forming a coffee cooking contrivance holding 70 litres. The various other chambers at the side and beneath serve for storing of the fuel and the kitchen utensils.

The copper is double sided; it consists of a seamless drawn, all nickel inner copper, with a hard soldered top closed by a double-sided steam-tight lid, and an outside copper made of copper. As a medium for the bath, boiling oil, etc., may be employed.

Attached to the outer copper is an expansion tube for the purpose of receiving the overflow of the heated bathing fluid. This expansion tube runs up and along the side of the chimney and terminates in a thin, open tube surrounding the chimney near the top. The bath requires neither manometer nor safety valve, while at the same time all danger of an explosion is excluded. A special contrivance serves to measure the degree of the bath.

The lid of the copper contains a safety valve, terminating in a specially formed bell, which prevents any solid parts of the food from boiling over.

The range proper, made of wrought iron, consists of a vaulted bottom, a cylindrical body, and a solid top plate. Fitted to the bottom is the fire-place, which extends in the form of an arch, and which is supplied with an adjustable tight-closing fire door. The extension of the fireplace in the form of an arch permits the radiating heat of the fire to act upon a larger surface of the copper, while it prevents an injurious effect resulting from the thin flames, and guarantees an increase in the durability of the fireplace, as of the bottom of the copper. Air is passed through between the exchangeable sides of the fireplace and the frame of the range, so as to prevent the frame from being overheated. At the back of the cylindrical part of the frame of the range a contrivance is attached to increase the heating power by guiding the fuel gases through a horizontal chimney tongue.

The rectangular top plate is turned up into an angle at three of its sides in order that remnants of food, water, or other fluids run off, and so avoid getting into the copper or other vessels.

As for the grate, one side of it is formed into the shape of a hook, while it is fitted in in such a manner as to allow it to expand at pleasure, which is of vast importance with regard to its durability.

The ashpit turns on hinges and opens at the bottom; the admission of air may be regulated by adjusting the drop by means of chains. This peculiar method of suspending the ashpit enables it to close itself automatically as soon as it strikes against any obstacle, while, simultaneously, any possibility of it losing its form or being destroyed is done away with.

The screw coupling between the inner and the outer copper, as also the secure screws for the copper into the top plate of the range, are fitted

Digitized by Google

out with red brass nuts incapable of rusting, while at the same time they may be easily tightened or loosened.

The smaller copper or coffee boiler, placed to the left of the main copper, is rectangular in section and is made of pure nickel. It is tightly closed by means of two half-lids. Between the two lids is the safety valve. Above the fire door is a tap and a rabbet for the purpose of filling the soldiers' flasks.

The sieve arrangement is of pure nickel and assures a thorough extraction of the coffee. Fireplace and grate are constructed on the same principle as the copper.

Copper and coffee boiler possess a common chimney capable of being turned down. The mouths of the chimney are separated by tongues, and may be wholly or partially shut by means of adjustable dampers. The fireplaces may be used simultaneously or independently of each other; each may be regulated by itself. The cross section of the chimney shows it to be oval at the bottom, circular and conical in form at the top. A ring attached to the chimney serves as a support to the lid of the copper when the latter is opened, and a support to the chimney itself when it is turned down. By means of one of the screws in the lid the chimney can be kept firmly in a horizontal position.

On the side of the copper, to the right of it, is a chamber for the fuel. It outer form is similar to that of the coffee boiler; within it contains two separate compartments in which coal and wood may be separately stored. The one for the coals contains a coal shovel, poker, and a rake to clean the flue and the fireplace. Beneath this chamber is a drawer containing a wooden stirrer, with a measure for measuring the contents of the copper, two meat choppers, a sharpening iron, six plates, three cups, and three can openers.

Between the chamber containing the fuel and the coffee boiler there are five other chambers, both in front and in the rear of the copper. The chamber in the rear of the copper can be opened by turning back a lid, to which a ladle and fork are attached. The large chamber to the right of the chimney contains the coffee mill, the coffee filter, and a vessel for ground coffee, as also for tins containing coffee beans, salt, pepper, and spices. Just to the rear of the chimney is a small chamber for the reception of tools and extra fittings; beneath it is a larger chamber for the meat-chopping machine. To the rear of the coffee boiler is a separate space for the reception of an air-tight wrought-iron tin can, containing a supply of the fluid required for the bath. A further free space between the copper and the chamber containing the fuel may be got at from the top, and is suitable for the drying of fresh wood. All these chambers and vessels are secured against any transmission of heat from the body of the range by means of a constant stratum of air.

The two rings at the back of the chamber containing the fuel are intended to hold the lantern. Within the compartment for the storing of the wood there is on one side a contrivance to attach the hatchet.

The vessels fitted to the hind carriage are made of wrought iron, and are protected against rust by having been zinced over or galvanized. The body of the range is coated over with a dark and suitable coat of

Digitized by Google

Fig. 1.

Fig. 2.

Digitized by Google

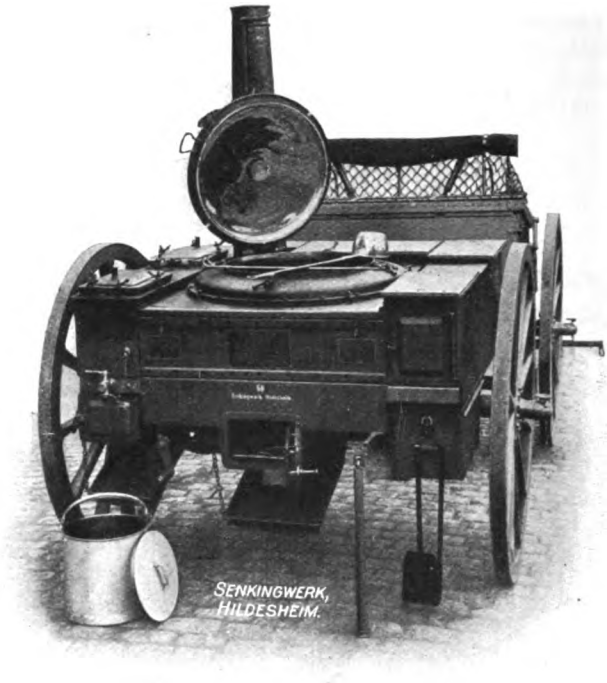



Fig. 3

Fig. 4.

Digitized by Google

paint. The surfaces of the copper and coffee boiler are galvanized brown.

All these chambers and vessels may be closed by means of hasps or turn buckles and padlocks.

The weight of the kitchen, with equipment, without stores and provisions, amounts to about 850 kgs.

The limber box is made of wood and fixed to the axletree by means of two clip plates. It contains various pigeon holes for the reception of 200 extra allowances (for the men), the extra ration (for the horses), and the stores. The lid opens by being turned backward and is lined with sheet iron. The box, to which a waterproof bag is tied, containing 20 kgs. of oats (part of the extra rations for the horse), affords seating accommodation for the driver and the cook. To either side of the guard irons are strapped the knapsacks belonging to these men; at the back is a space for the saw and the folding forage ladder and tilt.

### The Result of the Trials.

As a result of the thorough driving and cooking tests to which a number of the models were subjected, a field kitchen was finally obtained, the chief characteristics of which may be summed up as follows:—

A four-wheeled vehicle for two heavy horses.

Fore carriage detachable from hind carriage, and each with a horse attached, manageable by itself.

A copper holding 200 litres in a boiling bath.

Coffee boiler capable of holding 70 litres of water for the purpose of making tea or coffee, or to dilute and increase the quantity of food that has grown thick as the result of having boiled too long.

Both coppers may be heated singly or simultaneously.

The fore carriage contains:—

200 third extra allowances (for the men), provisions of food for daily use.

Three extra rations for the draught animals.

Folding canvas water pail, saw, pickaxe, axe, hatchet, and other carriage tools and fittings.

Stores and stable supplies.

Driver's and cook's baggage.

The hind carriage contains:—

The cooking contrivance.

Cooking utensils, including meat-chopping apparatus and coffee mill, fuel.

The boiling bath surrounds the whole of the inner copper, and absolutely prevents the danger of the food being burned, while it enables the advantageous utilization of the self-cooking apparatus, and serves as a heating apparatus.

The range may be heated by means of coal, patent fuel, wood, peat, etc., and that in the course of a march without necessitating a stop.

While the food is cooking (1 to 1½ hours) the ashpit and damper are closed. In consequence of the heat stored up in the copper, and owing

Digitized by Google

to the bath, the food continues to cook as in a cooking apparatus, and is ready at the end of the normal cooking time.

The food still possesses, even after 12 hours (provided the copper has not been opened in the meanwhile), a temperature of 140° Fahr. Should the need exist of keeping the food for a longer time, all that is necessary is to make up the fire again every 12 hours or so, when the food will still be palatable even up to a period of 72 hours.

The copper may be easily cleaned.

The kitchen, which, including the total outfit, provisions, and filled coppers, does not weigh more than 1,310 kgs., may and is able, owing to the advantageous form of its construction, which does not require a complete counterpoising or balancing, to follow infantry wheresoever this be necessary, even along unbeaten roads.

Owing to the fact that the fore carriage may be easily detached from the hind carriage, and each be driven independently, it is possible, especially at night, to provide the troops facing the enemy with warm food.

Furthermore, while the food is being distributed, or the kitchen is being cleaned or re-filled or heated, the fore carriage may be sent back for fresh provisions.

The use of the kitchen as a self-cooking apparatus offers the following advantages :—

(*a*). The preliminary cooking may be done at night or early in the morning before the troops march off.

(*b*). Smoke during the march, which might tend to annoy the troops and prove a means of observation to the enemy, is done away with.

(*c*). The consumption of fuel is smaller than in the case of a constant heating.

### The Field Kitchen in the Manœuvres.

Several of these field kitchens had already been put into practical use during the manœuvres of 1907, but during the Imperial manœuvres of 1908 in Alsace-Lorraine a larger number were practically introduced.

With regard to the results obtained, the *Cologne Gazette* of October 9th, 1908, wrote as follows :—

"In consequence of the new Field Service Regulations and similar Orders, our Army Provisioning Service has been thoroughly reorganized, the advantages of which reorganization, even though but on a small scale, we had already an opportunity of recognizing last year; a far better occasion of studying them, and on a far more extended scale, was offered us during the last Imperial manœuvres. We are alluding to the introduction of transportable field kitchens, in which the Emperor has taken a great interest, and which, carrying along as they do meat-chopping apparatus, coffee mills, and butchers' knives, have already proved themselves practically serviceable years ago in the Russian Army. It was in the course of the past year however that, for the first time, four of these field kitchens, of various designs, were taken along into the Imperial manœuvres by a battalion each of the 55th and 74th Regi-

Digitized by Google

ments respectively. After a final model had been determined upon, a sum of 1,000,000 marks was formally voted in the Army Estimates for 1908, for the purpose of field kitchens for the Army. For it had become evident, in the most convincing way possible, that the presence of field kitchens during manœuvres and in the field was a most excellent means of increasing the health and strength of the troops, and, with these, their fighting ability. As a result, these field kitchens have been subjected on this occasion to a considerably larger series of tests, and that on a far more extended basis. Thus two whole brigades—the 59th Brigade Infantry (30th Division of Infantry of the XV. (Blue) Army Corps) and the 66th Brigade Infantry (33rd Division of Infantry of the XVI. (Red) Army Corps)—were now completely equipped with field kitchens, so that the practical test could be undertaken with a total number of 50 field kitchens. He who annually has taken part in the great manœuvres will certainly have had ample opportunity of seeing for himself, in the course of the bivouacking, that the troops, after an exhausting day's march, possibly followed by an engagement, have, partially owing to fatigue, partially in consequence of a direct antipathy against doing their own cooking or of the bother of cleaning their cooking utensils, partially, too, because the camp provisions arrived at too late an hour, and that thus the opportunity of turning to rest was delayed, have, be it repeated, preferred, rather than cook the contents of their tins, either to eat them in the raw state, or even to throw them away altogether. Some of the men, indeed, frequently will rather rest satisfied with a crust of bread than do any cooking, and have but one thought, namely, that of turning in as quickly as possible.

"No one can deny this who has had any experience of men in the field. The result is however that the fact of this insufficient means of nourishment causes the men to grow ill-humoured as soon as they have to undergo any great fatigues, while at the same time it lessens their power of resistance.

"What a different thing was it on this occasion, during the late Imperial manœuvres, for the men belonging to the brigades that had been fitted out with field kitchens! These regiments, after breaking up their camps early in the morning, had to do some pretty severe marching through rough and rugged tracts of land, and it was not till noon that at times the engagement could take place, and they knew it would be late in the night before they would have any opportunity of turning in to rest. Notwithstanding fatigues and hardships however these men remained in good spirits, kept up their strength, and were able to conclude their day's work in the most satisfactory manner.

"Even on the last day of battle, when the Heights of Memersbronn, held by the Red Division, were stormed by the Blue Division, the field kitchens of the 59th Brigade Infantry followed the troops at some distance from the scene of engagement; they remained under cover in the rear of a village, and were so near that immediately after the close of the engagement the troops could be supplied with food. Among some of the sections of these troops tea or coffee was distributed of evenings, and there is no saying how refreshed those of the men were who, while doing duty at the outposts, were served with hot coffee, the kitchen

Digitized by Google

almost approaching the picket chain. It was particularly the men belonging to those regiments that had brought field kitchens along into the manœuvre who attracted general attention in consequence of their bright, ever-contented manner, even in the very midst of great fatigues.

"The practicability of these field kitchens, which consist of limber box and kitchen cart, and which are in no way meant to supersede any private cooking, has again been clearly demonstrated during the Imperial manœuvres, all the more as these kitchens offer further advantages for the troops that cannot be undervalued. For the transportable field kitchens, beyond the fact that they save the men the trouble of cooking for themselves, and that they enable a regular and constant supply of hot tea or coffee, still present the further advantage of a more rational utilization of the provisions, since less of the quantity and quality of these last is wasted than when they are distributed among a large number of the men in camp previous to the preparation of the food. Furthermore, these kitchens grant the possibility on the field, where much difficulty is often caused by the lack of good water, of utilizing larger quantities of otherwise poor water; while again by means of them the drying of firewood, which during rainy weather is often wet and damp, is facilitated; lastly, they are able to supply the men in the field with warm water for washing purposes, a fact of vast importance certainly since it is in the interest of the bodily cleanliness of the troops.

"If necessary, the coppers, fitted out as they are with manometers, may also be employed in the kitchens of the barracks. All these facts recommend the introduction of field kitchens throughout the Army."

Thus we see how these field kitchens have fully proved their practicability in the course of these manœuvres; and if a final decision in the selection of a definite model was only arrived at after a long series of trials, extending over many years, during which the models were subjected to severe driving and cooking tests both in hot and cold seasons of the year, on plains and in the mountains, on morasts, on sandy and on rocky soil, it may be regarded as a proof that the Military Administration was determined to consider most carefully every eventuality that might arise in the hour of need, that it was ever conscious of all the responsibility attaching to its decision, and that therefore it is deserving of our absolute confidence with reference to its final choice.

It will be the foot troops who will, in the first line, require to be fitted out with field kitchens; to these at a later date the field artillery may be added. As for the cavalry, it will be a question of a later consideration whether they too shall receive field kitchens in place of their self-cooking contrivances; as also whether the field ambulances, *inter alia*, are to be relieved of a part of their present cooking utensils by the substitution of field kitchens.

Digitized by Google

## MIRRORS FOR SEARCH-LIGHT PROJECTORS.

(Reproduced by permission).

An article in the October number of the *Rivista Maritima* deals with mirrors for search-light projectors.

The writer points out that the Russo-Japanese War gave considerable impetus to the consideration of metallic mirrors; that very little has been heard of them lately, but that probably experiments are still being made. No definite conclusions have however been arrived at.

Unbreakable qualities in a mirror are of great importance, but the essential part of the projector is the mirror, and an inferior mirror cannot be accepted merely because it is unbreakable. If the best mirror is fragile it must be adopted and easy replacement provided for.

The reflecting surface of the silvered glass mirror is of course also metallic, but in this case the glass is a necessity to protect the silver from tarnishing, and it also serves to form the parabolic surface which has been found difficult with metal.

In this discussion it will be assumed that the shape of the mirror is equally good in all cases.

Metals vary in their reflecting power, and this also varies with the colour of the rays. In Diagram I., which is taken from the experiments

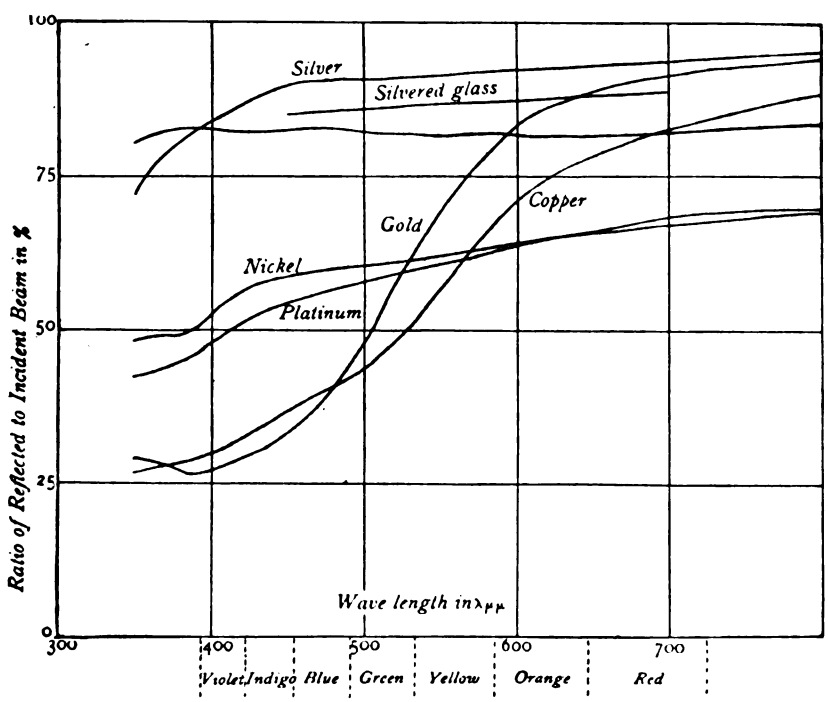



DIAGRAM I.

Digitized by Google

by Ruhens and Hagen, the abscissæ are the lengths of the waves of light, and the ordinates are the relations between the incident and reflected light.

The rays of light which are visible are those between 400 and 700.

It is obvious from this diagram that silver is the best reflecting surface, and the only metal which approaches it is gold.

Gold can easily be deposited on a form and keeps its surface untarnished; for silver the glass protection is necessary, and in its passage through the glass and back again after reflection, a certain quantity of light is absorbed according to the quality and thickness of the glass.

We may take it that about 3 per cent. of the light is lost in each passage through the glass, so that we must deduct 6 per cent. from the ordinates of the silver curve, Diagram I., and so get the curve for a silvered glass mirror shown in Diagram II.

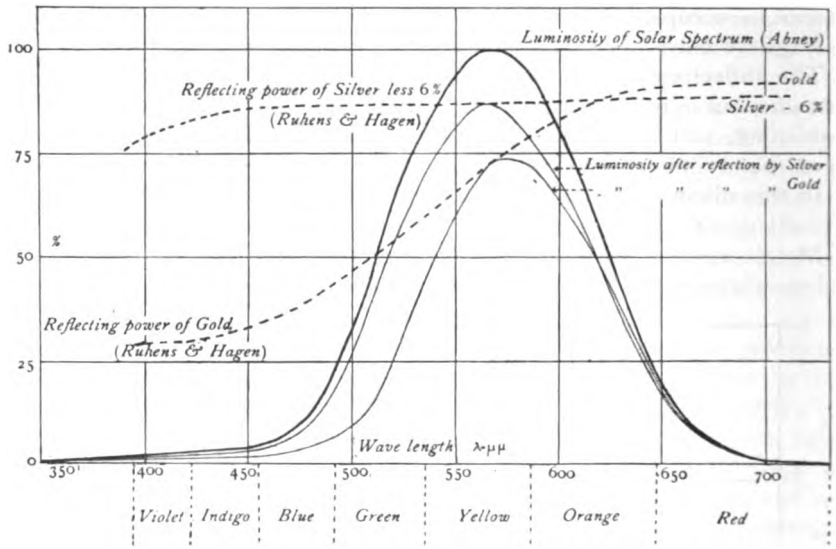



DIAGRAM II.

The silvered mirror still shows its superiority over the gold, for whilst reflecting almost equally well all rays, it has a distinct advantage for the rays between 500 and 600, which are those more efficacious for the visual phenomena.

It is necessary to study mirrors in relation to the light with which they are to be used. Recent reliable data on the distribution of the luminous intensity in the voltaic arc are not available, but as the arc has a tint very nearly the same as that of the sun, it may be assumed that the composition is the same in both cases.

The curve of the luminosity of the solar spectrum, in Diagram II., represents approximately the distribution of the photometric intensity of the normal spectrum of the sun, and also, it is assumed, of the arc.

If now we multiply all the ordinates of this curve by the corresponding ordinates of curves of power of reflection of the gold and silver mirrors,

Digitized by Google

we obtain curves of luminosity which, with their areas, represent the total reflected light of the two mirrors.

Integrating the three curves between 400 and 700, which practically represents the limits of the visibility of the spectrum, the areas may be represented by

| | |
|---|---|
| Solar or arc light ... ... ... ... ... ... | 5,380 |
| After reflection by silver mirror ... ... ... ... | 4,625 |
| After reflection by gold mirror ... ... ... ... | 3,700 |

The silver and gold mirrors reflect respectively 86 and 70 per cent. of incidental light, or the silver mirror gives a beam 25 per cent. more powerful than the gold.

The silver mirror really gives better results in practice than these figures would indicate, because, although in intensity the two beams (as measured, say, in candle-feet) may be the same, the superiority of the silver mirror is very marked with lower wave lengths, and the latter are those which affect the eye most. We should therefore expect to get a longer range with the silver than the gold mirror.

o o o o o

It seems strange that, in spite of the incontestable superiority of the silver mirror, some people assert that the gold is equally good. It is true however that no reports of definite comparative trials have been published.

A competent officer of a foreign Navy, who carried out trials for his Government, expressed to the author the decided opinion that the silver mirror is equal to a gold mirror of 1½ times the size, and an experienced officer of the Italian Navy assured him that there is no great difference between the mirrors. The author suggests that such a diversity of opinion could perhaps be explained, if the circumstances, under which the experiments were made, were known. The opinion may be based on the visibility of a far distant object affected by the conditions of the atmosphere, and the colours of the object and background.

We can consider the influence of colour by taking a limited case which could not occur in practice, but which will serve as an illustration.

Take two projectors identically the same except that one has a gold mirror, the other a silver. Direct the beams in two identical objects of yellow colour, and such that their surfaces can only emit rays between 530 and 700. Since only these rays can be emitted, the other rays of the beam of incidental light have no effect—as if they did not exist, and therefore the illumination of the two objects may be expressed by the areas of the two curves between 530 and 700, or

| | |
|---|---|
| Silver mirror ... ... ... ... | 3,600 |
| Gold mirror ... ... ... ... | 3,150 |

Assume now similar conditions for the background, that it is green and only emits rays between 400 and 560.

The illumination of the background may be expressed by

| | |
|---|---|
| Silver mirror ... ... ... ... | 2,250 |
| Gold mirror ... ... ... ... | 1,465 |

Digitized by Google

The difference in illumination between the object and background is therefore

| | |
|---|---|
| Silver mirror ... ... ... ... | 1,350 |
| Gold mirror ... ... ... ... | 1,685 |

And since under illumination objects lose their colour, and only make their existence known by the difference of their illumination and that of their surroundings, and since the silver mirror lights up well both background and object, the latter will be more visible when the gold mirror is used and the difference in illumination of object and background is greater. A case of this nature is that of a yellow house surrounded by green foliage.

But such conditions of superiority of the gold mirror cannot exist when it is used on the sea. The sea illuminated by a beam from a projector appears completely black, and as a background absorbs all luminous rays; the ship, painted white, buff, or black, is an object which reflects equally all rays of the spectrum, and there will be reflected from the object, in a measure more or less reduced according to its power of absorption, a light identical in composition to that of the incidental beam, and it is the total of this light which makes the object visible against the black background of the sea. All rays are useful, and therefore in this case the superiority of a silver mirror is obvious.

o o o o o

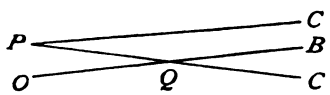
The space through which the beams travel can however influence an opinion on their relative merits.

The yellow beam of the gold mirror is less affected by the presence of damp vapour, which as one knows absorbs particularly rays of minor length beyond the green towards the violet.

The white beam richer in these rays becomes attenuated, but can never fall below the power of the gold beam, which has already lost these rays in reflection from the mirror.

The light carried to the object is therefore always greater with the silver mirror than with the gold, but tends to become more equal when the object is distant and the atmosphere damp. But it follows that, because the silver beam loses more light on the way, it illuminates the atmosphere more and makes its course more visible. The luminous pencil dazzles the observer, but above all affects the contrast between object and background.

Suppose P is the projector, PCC the beam, B the object, O the observer, about 10 mètres from P. Then he sees B through a stratum QB of the atmosphere beaten by the beam.




It follows that the background against which the object is seen is no longer black, as the sea illuminated by the beam is, but becomes light, whitish, and so much more so as QB becomes deeper.

Digitized by Google

The effect of contrast between object and background is therefore less, and the visibility of the object is consequently less; this explains why the object is more visible at the edge of the beam than in the middle, and why the object is more visible when the observer is placed so that the line joining the object and observer makes about 30 degrees with the beam.

With the gold mirror these disturbing conditions are less accentuated, and other conditions being equal, the visibility of the object is greater.

To sum up :—

(*a*). Silvered glass gives a beam about 25 per cent. more powerful than gold.

(*b*). Given that the gold mirror gives a beam poorer in green-violet rays, under conditions of colour of the object the gold mirror may be slightly superior to the silver.

(*c*). The effect of the atmosphere tends to equalize the power of the beams when the air is very damp.

(*d*). The gold mirror illuminates the atmosphere less, and therefore presents the disturbing influences to an observer near the projector in a lessened form.

It may be noted with regard to the last that the same effect can be produced by observing through a yellow glass, and the same impression with a silver mirror as with a gold can be obtained by using an appropriately coloured glass.

The author concludes that it would not be bad practice to provide yellow glasses for use under certain conditions.

E. G. Godfrey-Faussett.

Digitized by Google

# *NOTICES OF MAGAZINES.*

## JOURNAL DES SCIENCES MILITAIRES.

*February 1st*, 1909.

A further instalment of the article on "Automobilism" considers motor wagons and their use. The provision of a good commissariat has always been a matter of the greatest importance, and no one now denies the advantage, for convoys, of mechanical over animal transport. At present infantry regimental transport is too small and slow to need motors, but cavalry divisions and cyclists' baggage trains are quite a different matter. Heavy wagons will be very useful for posts off a railway line, though they will only be able to take reduced loads on account of the bad roads. Motor wagons must fulfil the following conditions:—(1), A strong motor; (2), metal-shod wheels for weights above 3½ tons, pneumatics for smaller weights; (3), total weight not to exceed 7 tons on account of liability to use on bad roads. If possible, trailers should be used, as a vehicle capable of carrying 4 tons can carry 3 and drag 3 simultaneously. Motive power should theoretically be electric, but the accumulators are too heavy, unless Edison's latest invention is successful. Steam may possibly be used, the weak points of such motors being the boiler. In the field motors must be capable of travelling on broken country roads, and, if possible, across country. A full description of the Renard train follows. Among its advantages are less wear to the road surface and no expense for india-rubber tyres.

The subject of this number's "Ideas on Instructing an Infantry Regiment," is protection. Protection is defined as the art of maintaining liberty of action. McMahon's army in 1870 is instanced as a case in which liberty of action was lost several days before the final catastrophe. It is the duty of the cavalry to ensure strategical liberty. The indispensable minimum of tactical liberty is that which ensures time and space for making dispositions for action. Advanced guards should be strong and pushed well forward. Making them strong is to make them bold, and not so likely to waste time making minute explorations of every inch of ground before any contact whatever has been made. In all circumstances advanced, flank, and rear guards should halt at every stop on convenient positions for resistance. Advanced guards do not manœuvre. They form a screen behind which the main body manœuvres. Flank guards are to prevent the movement of the main body being interfered with. They must therefore hold out to the last. After a retreat outposts should be furnished by the main body, not by the rear guard. Outpost sentries should never be single, specially with young soldiers and reservists.

Digitized by Google

Experience shows that if sentries are alone they tend to drift together. When attacked, outposts must not retire unless in danger of being captured as their capacity for resistance is greater than is generally supposed. The question of providing protection for troops in action is often overlooked. Detachments should be posted on all sides; an *échelon* formation which can hinder a flank attack by attacking its flank in turn, is the best. The results of any observations made should be communicated to other arms. The cavalry outposts act in the same way as the infantry, but can operate over a greater sphere. On account of the great services rendered by the mounted scouts attached to Russian infantry, 12 men per regiment are to be trained to act on the same lines in the French Army. They should be kept to scouting duties as much as possible, and should never be used as despatch carriers when cyclists or other means are available. To be defeated is a misfortune, perhaps unavoidable; to be surprised is shameful and can never be excused.

*February 15th*, 1909.

The Latil train is a rival to the Renard. It consists of a motor mounted on two wheels, which, attached to any carriage provided with two ordinary wheels, forms a special vehicle. As the driving mechanism is concentrated on the front axle, boxes can be hung about the rear axle, thus giving a dead weight of 2·7 tons to carry a useful load of 5 tons.

Considering the types of transport, horses are recommended for regimental wagons, as these must be taken right into camps, and these are often only connected to main roads by lanes impassable for motors.

The two types especially suitable for heavy transport are motor lorries carrying 2 tons and worked by 2 men, and Renard trains carrying 12 tons and worked by 3 men. The speed in each case is 7½ miles an hour.

Motor transport for hospital work is strongly recommended. It is of course quite out of the question for the preliminary work of collecting the wounded under fire, but motor ambulances running 10 miles an hour would soon remove the wounded from the collecting stations on the battlefield to the field hospitals in rear. On account of their speed, far smaller numbers would be required, which, considering the great crowd of vehicles with an army, would be an additional advantage.

Motors might also be used by the pay and postal departments. Germany uses light motor cars and motor bicycles for the latter.

The article on the Russo-Japanese War considers night attacks. According to a Japanese officer the Japanese infantry is the best in the world. Fortification, according to him, is not used for the defence, but as a means of resting during the advance; and as each step in the advance is fortified, strong reserves can be dispensed with. The Japanese practice, in peace, night attacks in absolute silence, directing them by luminous signals from the officer's pocket lamp. They prefer the German system of artillery fire to the French sweeping system.

Accounts of three night attacks are given—two Japanese at the

Digitized by Google

Sha-ho, and the successful Russian attack on Putiloff Hill, when 11 guns were captured. In the first case the Russians apparently had no outposts; in the second they mistook the Japanese, who were wearing white caps, for their own troops. The ground was first carefully reconnoitred and the direction of attack marked by branches of trees. Each unit had its point of assembly and point of direction laid down. In the attack on Putiloff Hill, the Japanese held their fire till the enemy was within 50 paces, hoping to crush him by fire at such a short range. But it was too close, and the Russians were completely successful, and also repulsed three counter-attacks made on the night of 17th to 18th October.

Almost all Kuroki's attacks at the Battle of Sandepu were delivered at dawn after a night march.

At Tashichiao the Russians built new epaulments at night; next day the Japanese bombarded the old ones, whose positions had been pointed out by their spies on the previous evening.

In "Instruction of an Infantry Regiment" the preliminaries of an action are considered. The "fog of war" is noticed, and the author insists that it will rarely lift. The Russian idea that it would do so, resulted in large reserves being kept, which came into action too late or not at all; whereas the Japanese generals, accustomed to carrying out their own plan without paying much heed to the enemy's intentions, threw every man into the fight, and though only equal in numbers to the enemy had far superior strength in action.

*March 1st*, 1909.

An article on artillery recommends three-gun batteries. It is argued that a battery's value in action depends entirely on the way its commander fights it, however well trained the men may be. It is impossible to command a four-gun battery by shouted orders, particularly if the captain's observing station is on the leeward flank of the guns. Telephones and signals are not in ordinary circumstances desirable; two guns are not enough for ranging, while often the fourth shot is unnecessary, so three guns are "necessary and sufficient" for that purpose. Eliminating the extra gun would increase the supply of ammunition available for the other three. There are two possible units in practice, the battery and the gun and its ammunition wagon. With shielded guns the section commander must take cover behind an ammunition wagon and cannot supervise more than one gun, consequently a two-gun section is obsolete. With three guns and six wagons, more spare numbers could be carried than with the present four guns and six wagons. These men would be very useful for running guns into action by hand, ammunition supply, and entrenching. With the present cone of dispersion for shrapnel, three guns can sweep the hundred mètres front allowed to a battery as effectively as four.

The German guns are severely criticized. They cannot in practice change their target for a new one to a flank without altering the positions of the guns themselves. The French artillery being able to traverse

Digitized by Google

their gun considerably without altering the position of the wheels can very easily alter their direction, consequently they have not the same need of keeping batteries in reserve.

The advice on the training of infantry considers the "preliminary combat" in this number. No fixed distances for frontage are any longer laid down. Troops should never be crowded into trenches so closely that they cannot take cover till actually wanted. Otherwise they suffer heavy loss for no reason, as the fire of a smaller number will be quite enough to prevent an enemy's advance. Mingling units in the firing line should be avoided as far as possible. It is better to allow each company to provide its own supports and reserves rather than to put a whole company in the firing line, with another company in support and another in reserve. The best formation for approaching is in a lozenge. To have two lines of companies, tends to result in two companies forming the firing line and two the reserve on every occasion, whatever the circumstances. Gun fire is effective up to 5,000 yards. Under artillery fire relief may be obtained by a short movement to a flank, as the German guns cannot easily alter their direction. Rifle fire is effective up to 1,400—1,500 yards. Every effort should be made to keep hidden, as "visibility draws fire, and fire provokes an answer." In Manchuria fire was often opened at long range; on distant localities more frequently than at definite targets. Field fortification is most important, but care should be taken that, on the offensive, it does not spoil the dash of the attack. Machine guns should be adjuncts of the infantry and cavalry. Night attacks must be practised.

Under the heading of "The Military Month," the selection of sergeants is considered. A corporal's duty is principally to set a good example to his squad, whereas a sergeant must use his intelligence more in carrying out his duties. Consequently, a good corporal is by no means necessarily a good sergeant, and the promotion of sergeants might be quite well made without considering whether a man had first got his corporal's stripes.—It is said that telephones are to be used by batteries at the practice camps this year.—A new model siege gun is about to be manufactured.

H. L. Woodhouse.

---

Journal of the Military Service Institution (U.S.A.).

Physical Training of Officers.—This article, by Colonel Charles Richard, Medical Corps, U.S.A., is a criticism of the methods existing in the U.S. Army for obtaining a state of physical efficiency in the higher ranks.

The test for field officers takes place annually and consists of riding or walking a certain distance in a given time. It usually resolves itself into a few weeks' violent training immediately before the test, followed by a period of comparative inactivity during the remainder of the year.

Digitized by Google

Colonel Richard objects to this test for two reasons. Firstly, because the officers who undergo it are not necessarily in a hard condition all the year round, and secondly, because the test not unfrequently causes a strain on the heart, from which it may never recover.

In place of this the author proposes that each officer should devote so many hours a month as a matter of routine to physical exercise, and that a certificate should be sent in every month certifying that this has been done. The object of this is, of course, to keep officers in continuous training for active service.

Should any officer be unable to satisfactorily carry out this physical training, Colonel Richard suggests that he should be brought before a Retiring Board.

The nature of the exercises suggested includes walking, riding, and the other usual outdoor recreations, amongst which the author considers golf to be the best.

This enforced system of physical training seems to be intended only for field officers and those engaged in staff, departmental, and other possibly sedentary duties, as, it is argued, junior officers employed in performing ordinary regimental duties meet with sufficient exercise in their everyday work to keep them fit.

THE MOUNTAIN TROOPS OF EUROPE.—By Capt. C. de W. Falls, 7th Regt., N.G.N.Y.—Capt. Falls contributes an article on the mountain troops of Italy, France, and Austria, in which he describes their origin, organization, and duties.

After the conclusion of the Treaty of Frankfort, France began to protect her frontiers with powerful fortresses constructed regardless of expense, the main object in view being to protect herself against her victor, Germany; however, under the new grouping of the European Powers, France soon realized that Italy would have to be regarded as a possible foe. Hence, she began to strengthen her Alpine frontier, roads, strategic railways, and forts being built to defend it.

Italy was unable to keep pace with this, firstly for financial reasons, and secondly, because her defensive scheme for her frontiers was not fully developed.

As a counterpoise therefore she originated her Alpine Corps, recruited from men belonging to the mountain districts.

Some years later France, who had by this time realized that ordinary line troops, which had up till then been employed on mountain work, were quite useless for the purpose, followed Italy's example. Twelve Chasseur Battalions were therefore converted into Chasseurs Alpines, each battalion having a strength of six companies, with mule transport. Mountain batteries also were organized.

Some time after this Austria, following the lead set by France and Italy, organized her famous Edelweiss Battalions, so named after their distinctive badge—the edelweiss, the mountain plant that only grows high up in the mountains.

These three countries—France, Italy, and Austria—alone have an establishment of special mountain troops, whose sole duties are to protect

Digitized by Google

their mountain frontiers. Other nations have sections of mountain territory in their defensive lines, but do not train any special troops for the work, which is carried out by whatever detachment may happen to be stationed on the spot.

Thus, practically, the whole of the Swiss Army is more or less trained to do mountain work; also that part of the German forces which may be stationed in the region of the Bavarian Alps, and those of Spain quartered in the Basque provinces.

The general lines on which the training of all the mountain troops takes place are much similar, but the French and Austrians appear to be much harder worked than the Italians. The training season begins about May, as soon as the snow in the upper valleys has sufficiently disappeared to allow the manœuvring of troops. The training includes divers military duties such as artillery and rifle practice, intelligence service, reconnoitring, roadmaking, and improvement of communications. Towards the middle of September the detachments return to their winter quarters, leaving only a few men at the outpost stations. The men left at these outpost stations are frequently cut off from all communication with the outer world—except by telegraph—for weeks together. Though the training of all the troops is much similar, there are great differences in *personnel*, uniforms, etc.

The French seem to have the best individual material, and the intelligence of their rank and file is much above that of the Austrians and Italians. Their clothing is good though their equipment is somewhat bulky.

The Italian uniform is very ill adapted, being showy, heavy, and much too conspicuous; their equipment also is very bulky. Considering that they were the originators of the frontier troops, they do not seem to have progressed much. The Austrian outfit, judged all round, seems to be the best.

In physique there is little to choose between the three; and all are remarkably fine—in the opinion of the author they are the finest troops that he has ever seen.

Their feats in the passing of mules and guns up and down precipices are considered miraculous, and from all points of view they seem to be a very efficient organization.

Utilization of the Night.—This article, translated from the French by Capt. Read, 12th U.S. Infantry, brings to notice some cases where night fighting took place in the recent Russo-Japanese War, and draws attention to the importance of this kind of operation for gaining positions which could not be taken by day.

In most of the instances quoted the actual attack took place either just after nightfall or just before daybreak, but there are others where the attack was made during the night in almost complete darkness, and it is with these latter that the article is chiefly concerned.

An account, believed to be very authentic, is given, showing how the Japanese captured some Russian guns after having taken a line of trenches and bayoneted their defenders.

Digitized by Google

At the close of the retrograde movement of the X. Corps, during the Battles of the Sha-ho, which movement was completed on the 13th October, Colonel Smolenski's Regiment of Artillery was situated in gun emplacements near Cha Ho Pow, with three companies of infantry as a local support. Part of the Gerchelmann Corps was holding a ridge in front of them.

During the night the Japanese, who had annihilated the portion of the above-mentioned corps in front of them, worked their way up to the batteries, where they arrived just before daylight. They then captured the batteries at the point of the bayonet. This catastrophe was due on the one hand to no information having been sent back to the artillery to let them know what was going on, and on the other to the fact that the Japanese, advancing in the uncertain light of a misty morning in uniforms which they had taken from the regiments that they had just annihilated, were taken by Smolenski to be Gerchelmann's troops withdrawing, and were not fired on by the Russians till they were within 150 yards.

It is pointed out also that guns have very little chance of escaping from hostile infantry which it has allowed to get within very short range, especially if, as in this case, the guns are loaded with shrapnel instead of case.

That the guns were loaded with shrapnel was due to the fact that they were firing over what they thought was their own infantry retiring at the spot where they supposed the Japanese reserves to be.

Another instance quoted of an assault being made in the dark is the attack that was made on Lone Tree Hill.

This hill had been lost by the Russians on the 15th October, and General Kuropatkin, considering it essential that the hill should be recaptured, ordered General Poutilov to do so.

The attack was ordered to take place at 6 p.m., to avoid the losses which would take place if attempted by daylight. It was made on three sides of the hill simultaneously, and in such darkness that the summit was barely visible. The Russian left came under a heavy fire during their advance, but made no reply until they reached the Russian trenches, where after a hand-to-hand encounter they turned the defenders out.

Their right and centre approached to within 50 yards of the trenches without being fired on, the Japanese no doubt thinking to repel them with short distance fire. They were however bayoneted and put to rout.

The Russian losses, though not numerically stated, were very small compared to those sustained by the Japanese, who left 1,300 dead on the hill.

Three unsuccessful attempts were made by the Japanese to retake the hill between midnight and 1 a m.

The above instances serve to show the possibility of executing decisive night attacks, and how, under such circumstances, the sidearm regains the value it had before firearms reached their present state of perfection.

The objection to such night attacks is of course the extreme difficulty of directing them—for instance, the only orders that could be issued to

Digitized by Google

guide the centre attack on Lone Tree Hill were to "march on the moon."

The author points out that the Russians were generally outmatched by the Japanese in these night attacks, and that the study of them during peace had been systematically ignored by the Russians.

A. J. SWINTON.

---

KREIGSTECHNISCHE ZEITUNG.

*September*, 1908.

As a result of the increased value of engineers, proved by the Russo-Japanese War, engineer brigades are being allotted to each of the Siberian Army Corps, the composition being :—

A. *Field Army.*

(1). Omsk Engineer Brigade :—

4th East Siberian Sapper Battalion.
1st East Siberian Field Balloon Battalion.
Field Engineer Park at Omsk.

(2). Irkutsk Engineer Brigade :—

2nd, 5th, 6th East Siberian Sapper Battalions.
2nd and 3rd East Siberian Pontoon Battalions.
2nd East Siberian Military Telegraph Battalion.
2nd East Siberian Field Balloon Battalion.
2nd East Siberian Wireless Telegraph Battalion.
Field Engineer Park at Irkutsk.

(3). Amurland (Priamur) Engineer Brigade :—

1st and 3rd East Siberian Sapper Battalion.
1st East Siberian Pontoon Battalion.
1st East Siberian Military Telegraph Battalion.
3rd East Siberian Field Balloon Battalion.
1st East Siberian Wireless Telegraph Battalion.
Field Engineer Park at Amurland.
East Siberian Engineer Siege Park.

B. *Fortress Troops.*

Vladivostok Sapper Battalion.
Vladivostok Marine Mining Battalion.
Vladivostok Fortress Telegraph Company.
Vladivostok Fortress Balloon Company.
Nikolajewsk Sapper Company.
Nikolajewsk Fortress Telegraph Company.
Amur Marine Mining Company.

Digitized by Google

The organization of an East Siberian Pontoon Battalion (2 companies) is :—

| | Peace Establishment. | War Establishment. |
|---|---|---|
| Cavalry drivers ... ... ... ... | 77 | 326 |
| Combatants ... ... ... ... | 490 | 739 |
| Transport non-combatants ... ... | 99 | 109 |
| Total non-combatants ... ... ... | 138 | 148 |
| Total of troops ... ... ... ... | 638 | 847 |
| Horses ... ... ... ... ... | 332 | 847 |

A Telegraph Battalion consists of :—

| | Peace Establishment. | War Establishment. |
|---|---|---|
| Transport soldiers ... ... ... | 214 | 431 |
| Total non-combatants ... ... ... | 273 | 490 |
| Total troops ... ... ... ... | 898 | 1,115 |
| Horses ... ... ... ... ... | 223 | 465 |

The efficiency of these units is said to be much improved by this new reorganization.

A. H. SCOTT.

---

## LE BULLETIN.

*January 15th*, 1909.

FIELD SERVICE REGULATIONS, GERMAN ARMY.—*Protection, Outposts.*—The line of resistance is usually the position of the outpost companies. These furnish piquets to their front varying from a squad to a section, each with its sentries and patrols. The local reserves are furnished independently of the outpost companies.

MODERN MILITARY INSTRUCTION.—An outline is given of a work bearing this title, by Capt. Maivetet of the French Army. The subject, treated in a most interesting manner, is studied under three headings :—

(*a*). Man and his action in war, from the physical and moral points of view.

(*b*). The regulations dealing with the training of the modern soldier.

(*c*). The particular part played in this training by the gymnastic instructor.

The first instalment commences with a psychological study, showing the emotions undergone by the human being confronted with the dangers of war, and the process of accustoming him to subordinate them to his sense of duty. The importance of the action of the reflexes in its bearing on peace training is discussed, as also the varying factors, patriotism, *esprit de corps*, cohesion, and discipline, etc., which go to augment moral force.—(*To be continued*).

ATTACK AND DEFENCE OF FIELD FORTIFICATIONS.—By Major Fritsch, Professor at the Berlin War College. A review is given in this and succeeding numbers. The chief *rôle* of field fortification is to enable a small force to contain a far superior one, so as to set free a prepon-

Digitized by Google

derating force elsewhere for offensive action. Recent wars in South Africa and Manchuria have shown the futility of uniform dispersion of forces over a wide front. When large forces are concerned the danger and loss of time involved in turning movements, and the magnetism which attracts two hostile bodies towards each other, make it improbable that the opponent will avoid a defensive position prepared beforehand; this dictum is certainly borne out by the Russo-Japanese War. It is therefore of the utmost importance to have such positions fully prepared for defence before the enemy appears on the spot. The author discusses the questions of siting of trenches, nature of artificial cover, the use of dummies, and hasty entrenchments.

*January 31st.*

Field Service Regulations, German Army.—*Protection* (*continued*).—Infantry patrols sent out in advance of the sentry line should, on returning, let the sentries know briefly what they have observed. In siege warfare outposts gradually merge into the first line as the defensive circle becomes more and more restricted.

Modern Military Instruction (*continued*).—The work of military organization in developing cohesion and *esprit de corps*. The abuse of the latter. The general condition of the soldier on joining his regiment. At 20, the age of enrolment, his physical condition is still imperfectly developed, and often deteriorated by the nature of his employment or the peculiar circumstances of his existence. He may be more or less affected by previous illness. His moral state is still more backward, for moral maturity is only reached about 30 years of age. From a psychological point of view, much depends on the class of society to which he belongs—under the two main headings, peasant classes and working classes. Each has its own peculiar characteristics, the former being hardy and brave, but dull witted and suspicious; the latter active, self-reliant, and *débrouillard*, but independent and undisciplined. It has been well said that these two classes form, respectively, the muscles and the nerves of the army.

Attack and Defence of Field Fortifications (*continued*).—The author discusses at some length the action in the field of heavy artillery by which he understands 6″ and 8″ howitzers. A *résumé* of engineer equipment and organization is given. The majority of German army corps have only one 3-company battalion of field engineers, carrying tools for itself alone (a certain number of full-sized entrenching tools now form part of infantry 2nd line transport), and 800 lbs. of explosives per company. All other stores and tools required are obtained from the siege park.

The Engineer Siege Park contains :—

4 vehicles of special engineer tools.
4 vehicles of mining stores.
48 tool carts.
50,000 sandbags.
500 wire cutters.
Escalading stores.
Shields.

Digitized by Google

The first *échelon* of the park carries entrenching tools for one-third of a division, stores for the construction and destruction of obstacles, 2,000 lbs. of explosives, rockets, corrugated iron, steel shields, sandbags, rope, wire, spikes, nails, etc.; also portable search-light projectors and—presumably—engines. Communication troops include balloon troops and telephone detachments. The balloon troop attached to an army is composed of two balloon sections and two gas sections. Only one of the two balloons carried can be sent up at a time as there is only one windlass cart. The average height to which the balloon is sent up is 600 yards, giving a sphere of observation of 4 to 10 miles radius. It is suggested that dirigibles will, when perfected, be free from almost all the faults of the captive balloon.

'E.R.'

## MILITÄR WOCHENBLATT.

*No.* 150.—*December 5th*, 1908.

A provisional training manual in the passage of obstacles has been recently issued in France. It is divided into three parts:—(*a*), The passage and destruction of ordinary obstacles; (*b*), the passage and destruction of trenches; (*c*), the passage and destruction of entanglements. Except in a few cases, operations are to be carried out by night The principles enunciated are very simple, and the simplest way of carrying out a task is to be considered as the right way; success is only ensured by rapid execution and little talk; the exceptional methods must however also be known and practised Some of the details given are interesting, *e.g.*, the wearing of special clothes by "destruction-sections," the colour of which is similar to that of the locality of the obstacles; the wearing of india-rubber shoes or wrapping up the feet in bandages, and in some cases blackening the men's hands and faces. Ladders and mélinite play a great *rôle* in the passage and destruction of the obstacles.

In order to encourage officers to perfect themselves as balloonists, the Italian Government states that wounds or illnesses contracted by officers whilst travelling on airships or balloons — even when on private journeys—will be reckoned as having occurred whilst on duty.

Italian officers and men who take part in speed or endurance contests on foot, on horseback, or on bicycles, are to receive exceptional additional pay, and officers who hunt can claim refund of transport expenses.

Under the title of "Armour in the Construction of Fortifications," a review of Lieut.-Colonel Piarron de Montdésir's book is given. This officer, who is a lieutenant-colonel of the French Engineers and a professor at the French Staff College, deals principally with the tactical and not with the technical side of the question. The book is divided into three parts; in the first part he deals with the development of "Fortification cuirassée" from 1815 till 1900; in the second with the existing fortifications in French and other countries, whether land, coast, or mountain defences; and in the third with possible future developments. The lessons to be learnt from Port Arthur are also dealt with in Part II.

Digitized by Google

*No.* 153.—*December* 12*th*, 1908.

A new grey-green uniform is to be issued to Italian troops by army corps, starting from the north, so that the XIIth Army Corps in Sicily will get it last. The officers will adopt the new uniform after all their men are equipped with it. This uniform is to consist of a jacket, vest, cap with peak and chin strap, and trousers. The latter fit into a pair of long laced boots, which, whilst being more pliable than a jack boot, are cheaper than boots and gaiters.

*No.* 155.—*December* 17*th*, 1908.

The new cavalry uniform—which is on probation—is being worn by one squadron of the "Florence" Lancer Regiment in Rome. It wore better in recent manœuvres than the old uniform.

*No.* 158.—*December* 24*th*, 1908.

Till quite recently there were no Turkish military journals, *i.e.*, papers in which the leading questions in military art were freely discussed. In the last two months however their number has increased to eight, which are:—

1. *Djeridei Askerijé*—an official organ for the promulgation of orders and notification of appointments.
2. *Medjmuai Fununi Askerijé*—a supplement to No. 1, published fortnightly by the General Staff. It chiefly contains translations from foreign military newspapers.
3. *Djeridei Bachrije*—a fortnightly naval paper, with an illustrated supplement every month.
4. *Asker*—a bi-monthly publication.
5. *Seif u Kalem* (pen and sword)—These last two are military magazines, edited by officers of the Turkish Army for the education of their brother officers.
6. *Ordu*—a weekly Adrianople paper.
7. *Makessi efkjari askerijé*—or *Military Reflections*, which is published weekly.
8. *Haftalig risalei askerijé*—a weekly semi-official paper published in Saloniki for the special benefit of the IIIrd Army Corps, and similar to the *Militär Wochenblatt*.

A work called *Muharebe dersleri* is also being published in six parts, viz.:—

1. Infantry fire tactics, and the company, half-company, and section commanders' handbook.
2. Infantry control in action.
3. How does a battery commander choose a position for his battery?
4. Field artillery in action.
5. Tactics of the three arms.
6. Tactical exercises for officers of all arms (with solutions).

Besides these, much literary activity is noticeable in military circles.

A. H. Scott.

Digitized by Google

## NATURE.

*December.*

WIRELESS TELEGRAPHY (*p.* 225).—The new wireless telegraph station at Bolthead, South Devon, was opened on December 11th. The station belongs to the Post Office, is about 15 miles S.E. of Plymouth, and is 350′ above the sea level, a height considerably greater than that of the Marconi station in Cornwall. The work was begun about six months ago, and cost about £10,000.

The range of the station is 250 miles. It will establish public communication with all vessels carrying wireless telegraphic apparatus, irrespective of the system of which they may have been installed. The apparatus is on the Marconi system. The aerial, which is 160′ high, consists of two central conductors and four arms radiating to small poles placed around the main mast, thus being of what is now known as the "Umbrella" type. Power is obtained from a 3-kw. alternator supplying current at 100 volts 50 cycles, which is transformed up to 15,000 to 20,000 volts. The alternator is coupled to a direct-current machine, which can be run either as a motor or as a generator driven by an 8-h.p. oil engine when it is required to charge the cells; in this case current can, at the same time, be taken from the alternator.

The signalling is effected by a key in the generator circuit controlling a magnetic key, which only allows the alternator circuit to be open when the current is at zero. This is now usual with wireless telegraphic work when the power is supplied by an alternator, in order to avoid sparking at the contacts of the signalling key. The sparking gap is of the standard Marconi type, and can be varied in length from 2 mms. to 8 mms.; it is completely enclosed to deaden the noise.

The receiving apparatus consists of a Marconi magnetic receiver which gives telephonic signals in the usual way, and a coherer circuit for "calling up," which is disconnected when receiving signals on the magnetic receiver. The coherer circuit can also be used in connection with a Morse inker. The normal wave length is 600 mètres, but this can be varied, and apparatus is provided to enable the circuits to be timed accurately in order to obtain the clearest signalling.

Everyone will welcome this further evidence of the development of the utility of wireless telegraphy, the traffic dealt with having increased in volume, and the ships carrying Marconi apparatus having increased in number.

EARTHQUAKES (*p.* 184).—Dr. Knott's work on this subject is confined to the physics of earthquakes, and gives an impartial statement of the principles on which seismograph instruments are constructed; they vary according to the purpose for which they are required.

The periodicity of earthquakes is discussed at some length, with the general result that there is little evidence of the reality of any of the periods believed to have been established.

STELLAR EVOLUTION (*p.* 191).—Professor Hale's work on this subject is an account of the study of stellar evolution, and of the methods and apparatus applied in attacking the various problems at the new solar

Digitized by Google

observatory on Mount Wilson, by means of its new equipment. Professor Hale looks upon the evolution of stellar systems, not as an entirety, but as a part of the general scheme of evolution which begins with the Beginning, and at present ends in the social systems which govern man. The great differences between the old and the new astronomy are pointed out with reference to the changes introduced by the application of photography. The sun is discussed as a typical star, and a description of the evolution of the spectro-heliograph, in which the author has played so great a part, is given.

A chapter on stellar temperatures illustrates the extreme delicacy of the apparatus with which Nichols, working at the Yerkes Observatory in 1900, was able to detect the heat radiations received from Arcturus and Vega. The former was found to send us heat equivalent to that given by a candle about 6 miles away, and Vega less than half that amount, if there were no absorption by the atmosphere.

The nebular hypothesis is discussed, and some interesting points are made on stellar development and the various stellar classifications in the light of recent research. The results obtained in the Mount Wilson laboratory, imitation of sunspot phenomena, seem to favour the view that a temperature classification of the stars on the basis of the relative intensities of the lines in their spectra is perfectly possible.

The making of the 60″ reflector in the Mount Wilson workshops is described and some possibilities of the new 100″ reflector now under construction are reviewed.

W. E. Warrand.

---

## Neue Militärische Blätter.

*Berlin, 15th December*, 1908.

Volunteer Army of the United States.—The General Staff of the United States Army has lately worked out a Bill, to be laid before the next Congress, which provides the organization for the formation of a Volunteer Army. In case of war the United States Army would then consist of three parts:—The Regulars, the National Guard, and the Volunteer Army. The latter would be formed during the course of a war or if war was imminent, but the consent of Congress is necessary, and—although formerly enlisted for two years—this army would now be dissolved as soon as possible after the danger of war has been averted or peace concluded. As soon as the President calls up the Volunteers, the Secretary for War would publish the rules and regulations for the recruiting of the men and the organization of the Army. Organization and discipline in the Volunteer Army follow on the same lines as in the Regular Army. The organization of machine-gun detachments, of hospitals, hospital trains, hospital ships, as well as of the whole sanitary and remount services, and the rest of the administration in rear of the Volunteer Field Army, would be left to the President to decide in accordance with the requirements of the moment. Similarly it rests with

Digitized by Google

the President—though subject to the consent of Congress—to appoint the officers required to effect the organization of units less than a brigade. The number of Volunteer generals is however laid down in the proportion of a brigadier to 4,000 men, a major-general to 12,000, and a lieutenant-general to 36,000 men. The Volunteer officers are, in the first instance, to be drawn from the Regular Army, and—on the recommendation of the Governors concerned—from the organized Militia of the various States and territories. But the number of Regular officers is limited in the case of infantry, cavalry, and artillery regiments to five each, and to five for every 12 companies of coast defence artillery. It is expected also that a large number of former officers, under officers and men of the Regular Army, will join as soon as the Volunteer Recruiting Depôts are formed, and it will then be possible to appoint them at once to those depôts with higher rank and increased pay. Though full information regarding the details of the above scheme are not available, there are several points of interest which are worthy of notice.

The difficulties—which were experienced by the Federal Government at the outbreak of war in 1861—have evidently not been forgotten by the American General Staff, but their efforts to remedy their existing deficiencies have not met with much success.

It is recognized that the Militia Forces of the several States and territories cannot be employed, for Federal purposes, outside the boundaries of their respective territories, and that the peace organization of these forces must be broken up on a general mobilization.

It is expected that the ranks of the new Volunteer Army will be filled up by the officers and men of the Militia Forces, who will volunteer for active service, but who will not submit to efficient training in peace time. It would be interesting to know whether the Regular units will be utilized to form the nucleus of the new Volunteer units, or whether they will take the field as intact Regular units, as in 1861.

It is noticed that a proportion of Regular officers will be drafted into the Volunteer units, and that the appointment of officers to the higher commands is reserved in the hands of the President, but "subject to control" by Congress. There seems some danger, in this control of patronage in the higher ranks by Congress, of the appointment of popular political magnates to the higher commands, rather than of their being filled by the selection of officers of scientific military attainments. The scheme merely provides for a paper organization, which leaves the complete formation of a field army to be deferred till after the outbreak of war, dislocates all organization in peace time, and relegates the formation of the indispensable auxiliary services to the time of emergency.

*22nd and 28th December*, 1908.

Under the heading "What can we Learn from the Japanese from the Night Operations in the Russo-Japanese War of 1904-5?" the writer discusses some points of very great importance, brought out in a book entitled *Training of Infantry in Night Operations*, and written by a Japanese officer, Lieut.-Colonel Tachibana.

Digitized by Google

The writer commences by drawing attention to the general unpopularity of night work, and says it is well known that many very able officers lay no value on night fighting, and even oppose night operations at manœuvres. "The night is no man's friend, and at all night work—even in peace—one has a certain uncomfortable feeling as one becomes aware of the dull noise of approaching masses of men, till at last from the mist or the darkness of the night a black something takes shape and rolls nearer like a broad wave of sinister menace, and finally threatens to fall on us with levelled bayonet and nerve-shattering yell." The writer points out that there was a time when it was asserted that the introduction of accurate low trajectory firearms put an end to all hand-to-hand fighting, or at least limited it to very exceptional occasions. The Russo-Japanese War—in which two nations were struggling for their existence with almost inhuman tenacity and national enthusiasm—has however proved exactly the opposite, more especially with night fighting. The German *Combined Training* says that night practices are indispensable, particularly night marching, even off the road. Troops must be prepared beforehand for the fight by night, but this can only be done by practising night fighting in its very details. The soldier must first acquire some precision in the use of his weapon, for its use by night makes such high demands on the man that he must not only know how to use it independently under all circumstances, but must also be practised in physically overcoming the greatest obstacles.

Going into the details of the training more closely, there are first and foremost two senses—hearing and vision—the sharpening and development of which are of especial importance for night fighting. Every man must be practised in distinguishing by sound alone, the step of an armed soldier fully equipped from that of the casual passer-by. The former has a heavy regular tread; the latter a lighter, freer, irregular pace. In the stillness of night the soldier must learn how to distinguish when detachments on the march halt and again move off. The men's powers of hearing must be so increased by long and careful practice that the direction and distance away of an approaching body of troops can be fairly accurately estimated. The writer agrees that this requires a sensitiveness which can only be expected from a fraction of the men. The men should be given practical examples in observing how, in marching through the dry undergrowth in woods, the cracking of branches and the rustling of the foliage can be heard at a great distance; how marching on hard stony ground is audible further off than the sound of marching on sand or turf; how wind affects sound; and how to some extent undulations and hollows muffle noise. The eye must be accustomed to the dark, and to distinguishing objects which generally appear quite different in the dark. In mist all objects appear much larger than they actually are. Distances appear greater. Practice must be given at finding one's bearings by the moon, the pole star, and the compass, "so that before all things the front is never lost." The writer then proceeds to detail the precautions necessary in an advance by night. Bayonets are to be fixed and the rifles carried at the short trail. All this is first to be practised without arms, then with bayonet-fighting muskets, and then—when sufficient pre-

Digitized by Google

cision has been obtained—with the rifle. As regards equipment, the difficulties must also be surmounted progressively, first without the pack, then with it empty, and then with it fully loaded; further, the practice must be commenced on level ground, then on broken ground, and finally on a site covered with artificial and natural obstacles. "Preparatory exercises ensure studious use of the obstacle course by day as well as in the dark." Fire is only to be opened under exceptional circumstances at particularly favourable targets, and care must be taken not to fire too high. Success in night fighting is only attained by regardlessly pressing on to the hand-to-hand fight, and therefore it is of the greatest importance to lay particular stress on bayonet fighting, so as to prepare the men adequately for night fighting.

For duty on patrols and in the outpost line, the writer says that particularly careful training is necessary of specially suitable and selected men. but he does not remark that the duty will fall very heavily on these men, As soon as a suspicious noise is observed, the man must immediately prostrate himself noiselessly and seek to determine the direction and distance of the approaching enemy. Indians can ascertain the approach of even single men at the distance of a mile, so why cannot German soldiers, or at least the most adept amongst them, learn to do the same? Woods, which furnish the patrols with cover from view by day, are to be avoided at night, also villages and farms. Note must be made of anything which will help to guide the patrol on the return journey, but the writer appears to overlook para. 261 of the German *Combined Training*, which advocates, as with us, the return of the patrol by another route.

Patrols should avoid collision with the enemy's patrols, but if one is encountered, "the patrol must at once climb trees and keep themselves hid in the foliage, or, if there is no time for this, throw themselves on the ground and let the enemy's patrol go past them; if this last course also is impossible, they must surprise the enemy and noiselessly cut them down."

In the case of marches across country of fairly large bodies of troops in close formation, the closed column of sections is the most suitable formation. The position of the commander is in front of the middle of his column, which he directs "by signs, whistles, or hissing sounds." The writer has nothing new to say about arrangements for keeping up communication or for conducting the march generally, but "in the assault the front ranks hold their rifles at the charge; the rear ranks, on the other hand, hold theirs upright in front of the breast, in order not to wound their front rank men with the sharpened bayonet."

The writer observes that in the Russo-Japanese War it was found inadvisable to fire at the retreating enemy after a night assault, as their own people from another detachment might be in pursuit and would suffer.

There is nothing to notice in the lessons drawn by the writer for the defence, but he finishes by saying that unfortunately the German soldiers do not come up for their service so excellently trained physically as the Japanese, with whom in all classes of the people great value is attributed to sport and physical exercises. He considers it would be wrong to make the training in night work the subject of an inspection. No decisive

Digitized by Google

battles have been fought by night, but in siege warfare and in the fighting round advanced positions the Japanese gained by night some striking successes.

In a notice of the training of our newly formed Officers' Training Corps, the critic observes that the chief aim seems to be to establish the apparent worth of all our reforms by numbers only; the inner worth of all portions of the newly-formed army is then to follow of itself!

In the issue of this magazine dated 15th January, 1909, the second of a series of articles on "Technical Means of Obtaining Intelligence" appears, dealing with airships. The writer describes the historical progress of military airships, and—after a reference to the efforts of Father Lorenzo de Guzmao in Lisbon in 1709, and the brothers Montgolfier in 1783 in Paris—he observes that in the Wars of the Revolution and of the First Republic there existed a regular balloon detachment. Its originator was the Engineer officer Meusnier, the inventor of the ballonet, an airbag for the preservation of the tight form of the balloon. He also pointed out the right methods for building a dirigible airship, but success was unobtainable through lack of mechanical motor power. Meusnier, together with Coutelle—whom he got promoted to captain—formed the *aérostiers militaires*, which were unquestionably successful before the fortresses of Charleroi, Nancy, and Ehrenbreitstein, and before and during the Battle of Fleurus (26th June, 1794). At Fleurus the divisional commander himself reconnoitred from an elevation of 500 mètres. The reports were fastened to arrows provided with red rags and shot to the ground, and it is said that the excellent use made of the Reserves was entirely due to these reports.

In 1794 the *école aérostique* was founded at Meudon, but it was closed by Napoleon in 1799. Napoleon was never able to appreciate the captive balloon, and the whole apparatus of a balloon detachment of that period was certainly most clumsy.

Before Venice, in 1849, the Austrians strove to throw explosive shells into the town by means of small free hot-air balloons. They also foreshadowed the manner of waging war from dirigibles in the future, by trying—with the assistance of the wind—to span a greater distance than their guns could carry.

In 1852 Henry Giffard attempted to construct a dirigible in Paris, replacing Meusnier's hand-power by the steam engine. An air balloon with an engine below it heated by a fire, is in any case a somewhat unsuitable design, but this attempt also failed through the excessive weight of the engine in comparison with the velocity obtainable. After the statical problem of the dirigible has been solved, this question of proportion of weight, next to that of the reliability of the motor, is of the first importance. While with animal propulsion we get about 10 cwts. for 1 horse-power, there are at the present day airship motors available in which 1 horse-power is got for 3 kilogrammes.

In 1859 we find the captive balloon in use at the Battle of Solferino, and later in the American Civil War. In 1866 the Austrians had provided a balloon detachment in case Vienna was besieged. During the war of 1870–71

Digitized by Google

balloon units with captive balloons were improvised by both sides. "But neither ours, which were used before Strasburg and Paris, nor the enemy's had any noteworthy results to record as regards observation." On the other hand, 65 free balloons left Paris during the siege and rendered excellent service. They were all spherical balloons of about 2,000 cubic mètres capacity, filled with ordinary gas; 164 persons, 400 carrier pigeons, and 215 cwts. of letters in this manner left the fortress, although it was closed to the outer world. Only five balloons fell into German hands, and two were lost at sea. Gambetta escaped in a balloon from Paris, which was fired at by German cavalry, but not seriously damaged, though Gambetta was slightly wounded. The writer here observes that a balloon hit by artillery fire will in most cases sink somewhat slowly, in case it does not catch fire, and points to the case of the two balloons in the last Gordon Bennet race.

After 1870 captive balloons were put to the practical test of war by French, Italians, and English in their colonies. "England took a step in advance when she gave up the manufacture of hydrogen in the field and introduced compressed hydrogen in steel cylinders." "In the South African War England used mobile, light field balloon units with great success, as at the Tugela, Modder River, Spion Kop, and Paardeburg."

The long duration of battles in the Russo-Japanese War favoured this means of obtaining intelligence. The Russians, the only military Power which still persevered in preparing gas in the field, manufactured their hydrogen, only when required, from aluminium and caustic soda. If only this question of a light, travelling, efficient gas-making arrangement was satisfactorily solved, an important step would be taken towards the application of dirigibles in the field. For the emptied gas cylinders, each weighing 1 cwt., mean bad ballast; one filling of the Zeppelin requires, roughly, 3,000 gas cylinders, each of 1 cwt., but this, of course, is an exceptional case.

Since the withdrawal of the troops from the Far East, Russia has taken up the reorganization of modern field balloon units, based on the experiences of other countries and also of those of the Russo-Japanese War. Russia also possesses eight fortress balloon detachments and a Balloon School.

The writer also refers to the English balloon organization.—*To be concluded.*

An article on "National Defence" in the Belgian Army has been translated in *La Belgique Militaire* of the 3rd January, and is quoted and criticized at some length in the *Neue Militärische Blätter* of the 15th January. The critic observes: "Although the evils of the antiquated system of allowing substitutes have long been evident to both the Parliamentary parties," hitherto neither has been brave enough to undertake its abolition and face the odium to which it would be subjected by the "propertied" classes. The introduction of the volunteer system with premiums in 1902 promised a middle course between the preservation and the abolition of the previous substitute system; but the improvement was really one in name only. The critic concludes by saying that the

Digitized by Google

situation is, at the time of writing, still tense. The Ministry does not wish matters to lead to a dispute not only in the Party, but partly also among its members. It apparently wishes therefore to postpone the whole scheme of reform until the next election in 1910, and the financial situation seems to favour such a course.

TECHNICAL MEANS OF OBTAINING INFORMATION.—The issue of the 23rd January contains the concluding article on the above subject. France has four companies of *aérostiers* with the engineer regiments, as well as a park at Belfort, Verdun, Epinal, and Toul. The centre of French military ballooning lies in the School of Aeronautics at Meudon. Turning to France, the writer observes that the first trials with captive balloons after the war of 1870, undertaken by the Guard Pioneer Battalion, were soon given up; in 1884 Capt. Buchholtz, of the Railway Regiment, appears as the head of an experimental station for captive balloons, which had taken up its home on the old Berlin Eastern Railway Station. Then the balloon detachment with the Railway Regiment at Schöneberg was established in 1886. The year 1901 brings the formation of the Airship Battalion contemporaneously with the move to the Tegel ranges. Two points to be noted in the development of Germany's balloon troops are the introduction in 1892 of the arrangement for filling balloons in the field, and in 1895 of the "Dragon" balloon. Till then, as described, hydrogen was made when required and the filling took three hours. "To-day, 20 to 30 minutes after the balloon detachment turns off from the column of march, the first balloon report from the observing officer can be in the leader's hands!" The hydrogen is carried, compressed at 150 atmospheres pressure, in steel cylinders of 5 cubic mètres contents. The Dragon balloon followed this achievement; it was constructed by Bartsch von Sigsfeld (who came to grief coming to ground in a balloon in Holland) and Parseval. To-day this balloon is in use in 15 States. The captive balloon could hardly be used in a wind of a velocity of 10 mètres per second, as the anchoring cable would be put to too much strain, and the pitching and swinging of the basket would make observation impossible. On the other hand, observation from the Dragon balloon is still possible for an experienced balloon officer, even in a tolerable storm, and the strain on the cable is considerably less. The shape of the Dragon balloon is a half upright cylinder, ending at top and bottom in a hemisphere. At the lower end are, beside the ballonet, the steering bag and the tail. By its position obliquely upwards into the wind the Dragon balloon opposes a minimum resisting surface to the wind in comparison with the spherical balloon. Moreover the wind, impinging on the lower surface of the balloon, tends to lift it "like a dragon," while it depresses the spherical balloon. So that the balloon can assume a more horizontal position in strong winds and a steeper slope in light winds, the anchoring cables pass through one running pulley and can be arranged to suit the degree of wind pressure. The Dragon balloon contains 600 cubic mètres.

The following comparison between the buoyancy of hydrogen and ordinary gas is made:—A cubic mètre of gas possesses a buoyancy of 0·7 kilogrammes; a cubic mètre of hydrogen, on the other hand, has a buoy-

Digitized by Google

ancy of 1·2 kilogrammes about, or nearly double that of gas. Buoyancy is defined as the difference of weight between the gas weighted by the balloon envelope, basket, detachment, and cable and the air displaced by the balloon. At present, in Germany, one balloon detachment is provided for each army, consisting of 15 6-horsed limbered wagons, 2 wagons with gear, each with 1 balloon, 1 cable wagon, and 12 gas wagons (2 balloon fillings). Two balloons are not sent up, but the second balloon and the second filling only provide a reserve. Two more fillings and a third balloon are carried with the "gas column." As regards the cable wagon, the Germans, contrary to the French, only use the hand winch with regard to its greater suitability for the field and mobility. The drum has 1,000 mètres of wire cable, "which is considerably more handy to use than the hemp rope used in many armies." The cable consists of 10 sections of 100 mètres each, connected with cable fastenings, so that the length of cable can be adapted to the wind, an advantage when changing position with a high balloon. It also lightens the task of changing damaged portions.

The German balloon detachment possesses the mobility of a field battery, an unconditional necessity. Its place is, as a rule, at the rear of the advance guard. The commander and the observing officer belong to the staff of the commander of the army.

For practical reasons the height of the balloon is restricted to the minimum required, the average height being about 500 mètres.

The useful radius of observation varies between 3 and 7 kilomètres, with "Trieder" glasses up to 12 kilomètres.

The writer discusses the advantages and disadvantages of the use of the balloon, and considers that when the other means of reconnaissance have established the enemy's advance on his position, when the deployment on both sides commences, and when the other means of reconnaissance can no longer serve in their effort to clear up the situation, then the moment has arrived for the balloon to be used.

The observing officer should report what the cavalry can find out only slowly or not at all, *e.g.*, direction of the enemy's advance, deployment, his distribution from front to rear, fortifications and obstacles, covered artillery positions (particularly of heavy batteries), reserves, where the flanks rest, the result of our own fire, the progress of our own turning movements, the enemy's bivouac fires, direction of his retreat.

The great importance of a uniform equipment for field and fortress detachments is obvious. The writer claims that Germany has got this, and that other States are striving energetically to obtain it.

E. G. WACE.

---

RIVISTA DI ARTIGLIERIA E GENIO.

*December*, 1908.

PHOTO-TOPOGRAPHIC MAP OF A PORTION OF THE COURSE OF THE TIBER.—Major Moris, who was the first head of the photographic section of the

Digitized by Google

Brigati Specialisti of Engineers, was the first to recognize the importance of photo-topography for military purposes, and instituted an important series of experiments.

The construction of maps of the area within the city of Rome being completed, it was decided to construct a map outside the city which might be of practical use, and a map of a course of the Tiber for 50 kilomètres was selected for the purpose. A preliminary reconnaissance was made in order to study the ordinary roads and the localities which would be useful for intermediary bases. The Tiber not having on its banks a good highway suitable for carriages, it was decided to make use of the river.

In order to obtain all possible advantage from the waterway, it was found convenient to carry all the material on rafts which were towed to Monte Stimigliano, where the material was disembarked and a floating aerostatic station formed. It was then necessary to descend the Tiber for 500 or 600 mètres and to anchor on one or the other banks of the river, or possibly in the middle of the stream if the banks were difficult of access, to inflate and ascend the balloon with its apparatus, and to make the photographs.

At the bottom of the rafts there were stored 100 cylinders, each containing 3 cubic mètres of compressed hydrogen, and on the right and left the material, consisting of planks, spars, etc., etc. On the deck, the materials for a wooden anti-malarial hut were stored. The car for manœuvres and the cases containing the photographic and aerostatic materials were also placed on the rafts, together with the mattrasses, cooking utensils, and other necessaries. The two rafts were coupled together by tresses.

The party consisted of 12 men, specialists and boatmen, commanded by Lieut. Benedetti, and towed by a benzine launch, started for Stimigliano on the morning of the 18th May. After a day of easy navigation they arrived at the station of Monterotondo, where they passed the night. They proceeded on the following morning, and after overcoming with much labour the confluence of the torrent Farfa with the Tiber, they arrived late in the evening at Passo Corese, and on the third day they anchored at Monte Stimigliano, near the small railway station.

Here all the materials were disembarked and a planked floor was constructed 7 mètres in width and 10 mètres in length, on which the anti-malarial hut, intended to serve as a photographic laboratory by day and as a dormitory by night, was erected.

A spherical balloon was used, the envelope being of sufficient strength to sustain the worst causes of instability caused by pressure of the wind.

*Photography.*—The camera used was provided with a Zeiss lens, which allowed a photograph to be taken instantaneously by the machine whilst in movement. The shutter of the camera was under the control of the operator at the station and was worked by electricity. The apparatus was enclosed in a wooden triangular case suspended from the balloon by three steel wires 10 mètres in length, to allow of the oscillations being sufficiently slow to guarantee the clearness of the image. The connecting wires were of steel with insulated covering.

*Gas.*—As the hydrogen generator could not easily be transported over

Digitized by Google

the cultivated fields, the gas was conveyed in Fenix cylinders filled at Rome from the electric office of the specialists' brigade.

On the morning of the 20th May the balloon was inflated and everything prepared for the ascent. At the first station the elevation was 600 mètres. A map having been photographed, the balloon was brought down by the aid of four men in 10 minutes. The frame containing the map was taken out and developed in the hut, the negative showing the best results.

After weighing anchor the descending navigation was commenced, and after crossing the Tiber the raft was again anchored at 500 mètres where the second station was established.

After developing the photographs and verifying that there was no discontinuity between the maps last taken and the preceding ones, they passed to the third station, and so on.

The number of calm days was not great, and the time for work was limited, as from 8 to 9 in the morning it was not convenient to commence work because of the strong shadows projected on the ground, and after 1 or 2 o'clock owing to the strong wind that prevailed.

It was found necessary to work with the greatest possible speed, profiting by favourable weather to execute all the photographic work that was possible; and in a second period with the aid of photography to go over the ground, fixing the serviceable points necessary for the triangulation and for the reduction of the maps to a scale agreeing with their adjustment.

It was necessary for special cases of work to acquire a practised eye; to estimate rightly the distance from one station to another and the height of the balloon; to avoid losing the time that would be taken up by direct measurement, and to judge when errors occurred, if the machine was in a horizontal position or inclined, verifying in doubtful cases by the development of the maps before proceeding further.

During the work several difficulties had to be surmounted, such as the recovery of the machine in high winds, the transport of the gas cylinders, the necessity of developing with the aid of ice owing to the excessive heat, and many others; difficulties which were overcome from time to time by the experience acquired by the *personnel*.

The number of stations averaged from 6 to 10 in a day; in days of exceptional calm they succeeded in doing as many as 12. The total number of stations was 90. After five or six stations, the balloon had to be reinforced by a couple of cylinders of gas, and on the following morning, before commencing work, with five or six cylinders. Further, after four or five days' work the gas in the balloon was used up and had to be re-inflated, so that the total quantity of gas consumed was 470 cubic mètres.

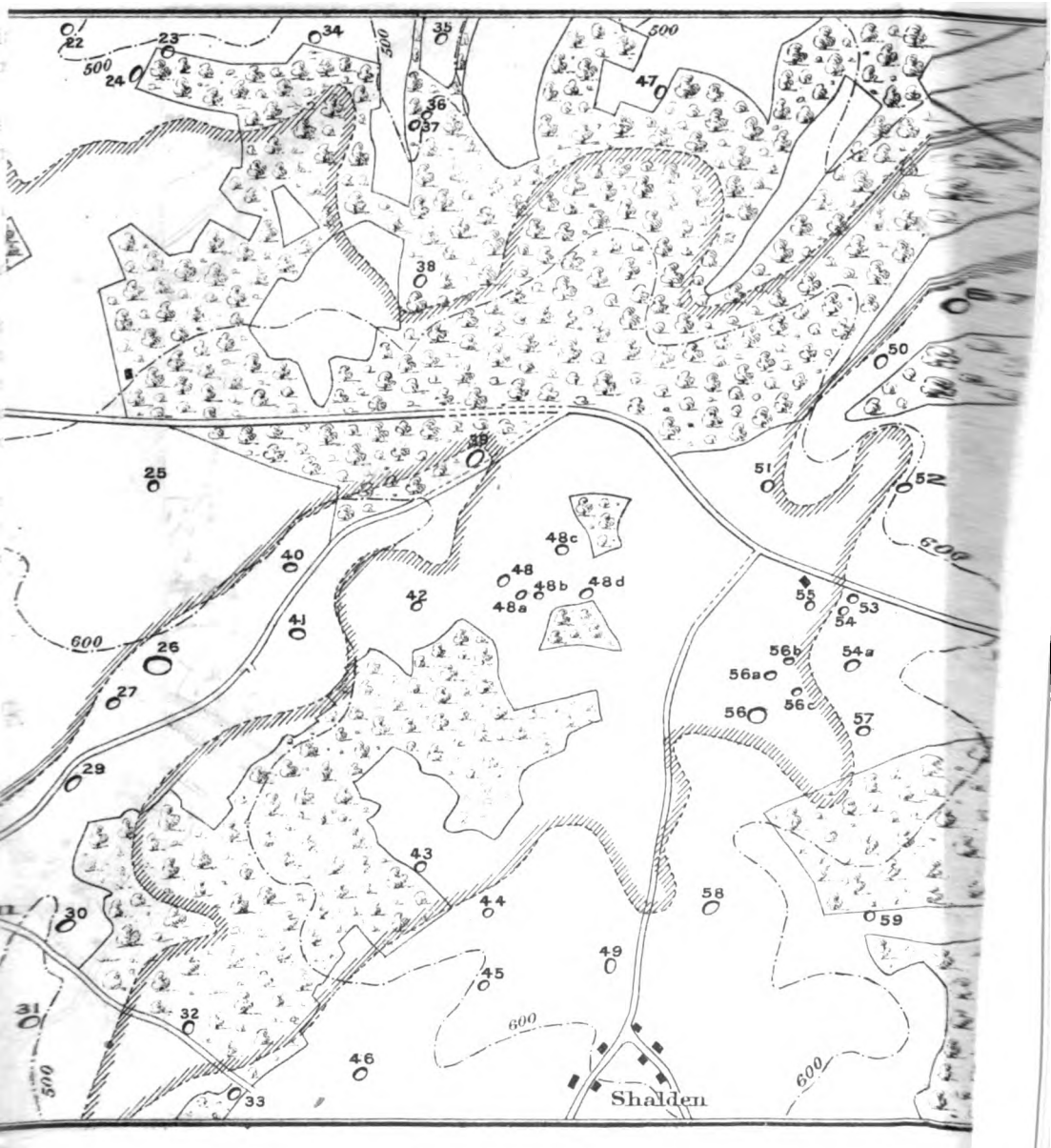
The work, owing to several days of strong wind and other days of rain, lasted for about a month, and on the 16th June, after the last station had been made above the Grillo Bridge, they returned to Rome. After making the necessary corrections in the laboratory to bring the maps to a scale of $\frac{1}{3500}$, they were printed and mounted in a panorama which met with the full approval of the military and civil authorities.

EDWARD T. THACKERAY.

Digitized by Google

# NORTH EAST HAM

## MAP SHOWING S




*Clay with Flints*

*Chalk with Flints*

*Swallow Holes* 30

Digitized by Google

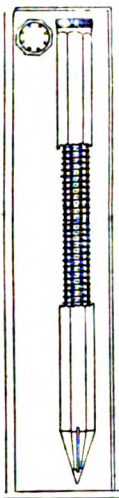
Digitized by Google

# THE CONSIDERE SYSTEM

OF

# REINFORCED CONCRETE

IS THE MOST SCIENTIFIC METHOD AT PRESENT IN USE.



**CONSIDERE SPIRALLED ARMOURING** gives a three times greater increase to the compressive strength of concrete than any other system.

It is specially applicable and economical for the construction of PILES, COLUMNS, BRIDGES, and WAREHOUSES.

**CONSIDERE PILES** *can be driven without any cushion or elastic cap of any kind.*

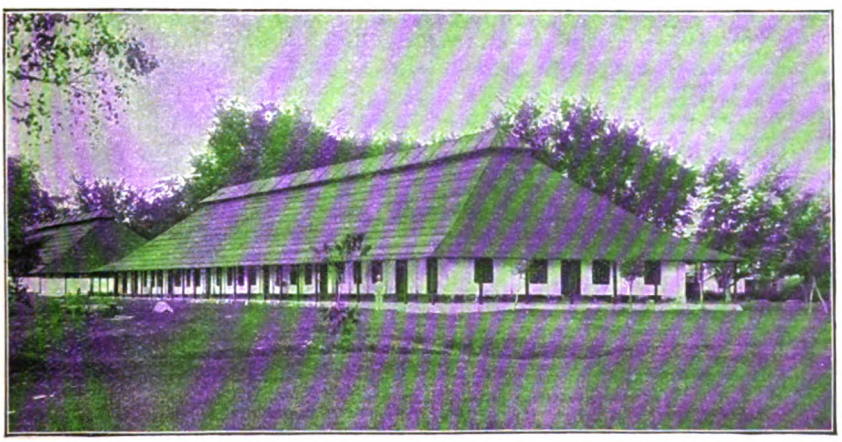
Preliminary designs, with approximate estimates, submitted for consideration free of charge. Complete working details and instructions for work in British Colonies at specially low fees.

For Pamphlet, Illustrations, and further particulars write

**The CONSIDERE CONSTRUCTION Co., Limited,**
**5, Victoria St., Westminster, London, S.W.**

# RUBEROID!
# ROOFING!

A High Grade Permanent Roofing Material in general use for all classes of Buildings. Its light weight as compared with other roof coverings makes it particularly useful where long transport of building materials is necessary.



Quarters of the Malay States Guides, Sepoy Lines, Penang, covered with Ruberoid.

Full particulars of cost and shipping weights gladly supplied. Our Illustrated Catalogue, No. 39, and samples sent post free on application.

**THE RUBEROID COMPANY, Limited, 81 & 83, Knightrider St., LONDON, E.C.**


Digitized by Google

# THE HELLIWELL PATENT "PERFECTION" GLAZING.

## ADVANTAGES.

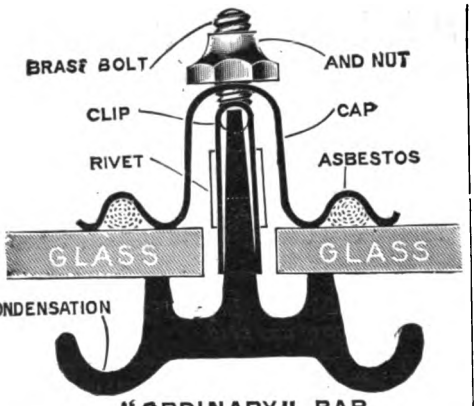
No Putty.
No Paint.

Guaranteed Water-tight and Dust Proof.

Easily Repaired.

Planks laid in Safety across Caps.

Steel Bars galvanized; and also entirely covered with Lead to prevent Corrosion.




"ORDINARY" BAR.
"Ordinary" Section.
BARS of different strengths, to carry up to 12ft. without Purlin.
CAPS in either Copper, Zinc, or Lead.

## EXTENSIVELY USED BY

H.M. Government, for Barracks, Dock Sheds, Post Offices, Stores, etc.

All the leading Railway Companies.

Municipal Authorities, for Markets, Baths, Libraries, Art Galleries, Schools, etc.

Also for every kind of Glass Roofing.

Head Office and Works: **HELLIWELL & CO., Ltd.,**
London Office: 11, Victoria Street, Westminster, S.W. **BRIGHOUSE, YORKS.**


# THE CAVALRY JOURNAL.

Published by authority of the Army Council and under the direction of the Commandant of the Cavalry School.

**Published Quarterly, Price 2/6 net. Postage 4d.**

**NOW READY. VOL. IV. No. 14.—APRIL, 1909. NOW READY.**

## CONTENTS.


1. **St. George: The Patron Saint of Cavalry.**
2. **Kaiserliches und Koniglliches Husgaren Regiment.** No. 12. By B. GRANVILLE BAKER.
3. **Mounted Infantry as Divisional Mounted Troops and With the Mounted Brigade.** By Colonel A. J. GODLEY, General Staff.
4. **The Battle of Warburg.** By Colonel H. PEARSE (Map).
5. **Tracking in the Desert.** By KAIMAKAN VON DUMREICHER BEY, Commanding the Desert Directorate of the Egyptian Coast-guard. Communicated by Lieut. C. W. HERRINGHAM, Inniskilling Dragoons.
6. **The Prussian System of Horse Breeding and Remounts.** By Colonel W. H. BIRKBECK, C.B., C.M.G. (Illus)
7. **Training of Yeomanry as Divisional Cavalry.** By A YEOMANRY OFFICER.
8. **A Paperchase in India.** By Lieut. A. P. HENEAGE, R.H.A (Map).
9. **Some Notes, Some Notions, and a Tackle for the Early Handling of Troublesome Australian Remounts.** By Captain R. W. W. GRIMSHAW, Prince Albert Victor's Own Poona Horse. (Illus.)
10. **Russo-Japanese War.—III.** By Colonel W. H. BIRKBECK, C.B., C.M.G. (Map).
11. **The French Cavalry.** By Lieut.-Colonel H. C. LOWTHER, M.V.O., D.S.O., Scots Guards.
12. **The 'V' Attachment for Girth on the Service Riding-Saddle.** By Major J. HORTON, Inspector of Saddlery (late Riding Master, 4th Dragoon Guards), the Inventor (Illustrated).
13. **Precis of a Lecture on the Collection and Treatment of Wounded Cavalry.** Delivered by Lieut.-Colonel MACPHERSON, C.M.G., R.A.M.C., at the Cavalry School.
14. **A Short History of the Guides Cavalry.** By Captain J. E. BLOIS JOHNSON, Queen's Own Corps of Guides.
15. **Organisation of the Strategical Cavalry.** Communicated by THE GENERAL STAFF, War Office. (Illustrated).
16. **Problem No. 7: Result.**
17. **Recent Publications.**
18. **Editorial Notes.**
19. **Sporting Notes.** By THE SPORTING EDITOR.



Subscriptions should be sent direct to:—

**The MANAGING EDITOR at The Royal United Service Institution, Whitehall, LONDON, S.W.**

Or, copies may be obtained by all Booksellers, Newsagents and Railway Booksellers, from

**The GILBERT-WOOD PRESS, 3 & 5, Arundel Street, Strand, London, W.C.**

Telephone Nos. 4083 and 1468 GERRARD. Telegraphic Address:—"GILBERWOOD, LONDON."


Digitized by Google

# HAWKES & CO., LTD.,

TAILORS AND MILITARY OUTFITTERS, CAP AND ACCOUTREMENT MANUFACTURERS,

14, PICCADILLY, LONDON.

*Patronized by many Officers of the Royal Engineers.*


## PROFESSIONAL PAPERS OF THE CORPS OF ROYAL ENGINEERS.

FOURTH SERIES.—VOL. I., 1905.

| | | | |
|---|---|---|---|
| PAPER | I. | **Simple Tunnel Work on the Mari-Attock Railway, Panjab,** by Capt. H. E. C. Cowie, D.S.O., R.E. | 1s. |
| ,, | II. | **Long Span Bridges,** by Max am Ende, M. INST. C.E. | 1s. 6d. |
| ,, | III. | **Recent Works in the N.W. Frontier Province, India** (Fortified Posts, Roads, Bridges, Civil Buildings), by Bt.-Col. G. K. Scott-Moncrieff, C.I.E., R.E. | 3s. 6d. |
| ,, | IV. | **Armoured Trains,** by Capt. H. O. Mance, D.S.O., R.E. | 3s. 6d. |
| ,, | V. | **Reinforced Concrete,** by Lt.-Col. J. Winn, late R.E. | 2s. 6d. |
| ,, | VI. | **Fortress Warfare,** by Capt. Moritz Ritter von Brunner. 9th edition of the work originally written by Field Marshal von Brunner. Translated by Capt. C. Otley Place, D.S.O., R.E. | 3s. 6d. |
| ,, | VII. | **Fortresses and Military Engineering in Recent Literature.** No. 43 of the "Mitteilungen des Ingenieur-Komitees." Translated by Capt. F. A. Buzzard, R.F.A. | 5s. |

VOL. II., 1908.

| | | | |
|---|---|---|---|
| PAPER | I. | **The Theory of Arched Masonry Dams,** by Capt. A. ff. Garrett, R.E. | 1s. 6d. |
| ,, | II. | **Report on Mechanical Road Transport for India,** by Capt. E. N. Manley, R.E. | 2s. |

The price of separate Papers as above, in paper wrappers, is net.
They may be obtained from Messrs. W. & J. MACKAY & Co., LTD., Chatham, or from any Bookseller.

Digitized by Google

## "ANCHOR" LINE.

## Passenger and Cargo Services.

LIVERPOOL to BOMBAY & KARACHI (*viâ* Bombay). Fortnightly.

LIVERPOOL to CALCUTTA. Fortnightly.

**All Vessels call at Egyptian Ports.**

Large New Steamers. Splendid Accommodation for Passengers. Electric Light and Fans. Excellent Cuisine. Every Comfort. Moderate Fares, both Single and Return.

Apply—"ANCHOR" LINE (Henderson Brothers), Ltd., Liverpool, London, Glasgow, &c.

## Nippon Yusen Kaisha.

Japan direct from London in 47 days, calling at COLOMBO, SINGAPORE and HONG KONG, by fast steamers fortnightly.
SANUKI MARU, 6,112 tons, May 1.
* MISHIMA MARU, 8,600 tons, May 8.
AWA MARU, 6,309 tons, May 15.
* This New Steamer calls at Marseilles

**To Japan, £54, 1st Class; £37 10s., 2nd Class; to other Ports at equally moderate rates.**

**ROUND THE WORLD, £107**

For Fares, etc., apply at—

**4, LLOYD'S AVENUE, LONDON, E.C.**

## Institution SILLIG,

**BELLERIVE, VEVEY, SWITZERLAND.**

**ESTABLISHED IN 1836.**

A HIGH-CLASS SCHOOL for the education of Boys in Classical, Scientific, Military, and Commercial Subjects, and for General, Moral, Mental, and Physical Development.

PRINCIPAL:

**MAX SILLIG—DE VALLIÈRE.**

## THE ARMY SCHOOL,

**Near MAIDENHEAD**

(Approved by the Army Council).

**Head Master:**

**E. G. A. Beckwith, M.A. Oxon.**

*(Late Exhibitioner of Winchester and Magdalen College).*

"A small public school in which boys from the age of twelve are prepared for the Army. The school buildings include a chapel, large dining hall, swimming bath, gymnasium, chemical and physical laboratories, besides 30 acres of playing ground."

SUCCESSES, 1907—1908.
Woolwich—One.
Sandhurst—Thirteen.
Qualifying Certificates—Sixteen.
Leaving Certificate—Five (Three Woolwich).

For FEES, etc. (reduced for Sons of Officers), apply to the Head Master.

## NAVIGAZIONE GENERALE ITALIANA.

The fine steamers "R. RUBATTINO" and "D. BALDUINO" sail alternately from GENOA TO BOMBAY on the 18th of each month, at 2 a.m.

FARES: 1st Class, £40 & £33; 2nd Class, £27 10s.; 3rd Class, £11.

GENOA TO ALEXANDRIA every Saturday, at 9 p.m.

NAPLES TO PALERMO every Evening, at 7.45 p.m.

For Tickets and Berths apply to the Co.'s Agents—

**ALFRED LAMING & CO., 8, Leadenhall Street, E.C.**

## NOTES FOR THE TACTICAL FITNESS EXAMINATION,

With Sample Schemes and Solutions,

By Major A. T. MOORE, R.E.

PRICE
TWO SHILLINGS AND SIXPENCE,
Post 3d. Extra.

Obtainable from the Secretary, R.E. Institute, Chatham, and Rees, Limited, 119, Pall Mall, S.W.

# G. E. CARRINGTON,

For many years Master Tailor, Royal Engineers,

## *TAILOR & MILITARY OUTFITTER,*

53, HIGH STREET,
OLD BROMPTON, KENT,

Attends CARLTON HOUSE, REGENT STREET, near Waterloo Place, S.W., every TUESDAY and THURSDAY, from 11 a.m. to 6 p.m., and at any other time by appointment.


Digitized by Google

# R.E. INSTITUTE

# New Publications.

---

MANUAL OF

## Road Construction & Maintenance

**Compiled at the S.M.E., by MAJOR PAUL, R.E.**

**FULLY ILLUSTRATED.**

Price **4s. 6d.**, Post Free. Members of the R.E. Institute, **3s.**

---

**ABBREVIATED NOTES**

**ON**

## Military Engineering

CONTENTS:

**Ropes, Spars, Tackles, Strength of Materials, Bridging, Field Defences, Camping Arrangements, Demolitions, Roads.**

**POCKET BOOK SIZE. INTERLEAVED.**

Price **6d.**, Post Free.

---

## Modern Sewage Disposal,

BY

**Capt. and Hon. Major G. B. WILLIAMS, R.E. (T.).**

Reprinted from the R.E. JOURNAL. Price **6d.**, Post Free.


Digitized by Google

The McKenzie, Holland, &
Westinghouse Power Signal Co., Ltd.

# POWER SIGNALLING

Electro-pneumatic,
all-electric, and
automatic signalling.

Address:

**58, VICTORIA STREET, LONDON, S.W.**

Telegrams: "POWERSIG, LONDON." Telephone: 890 Westminster.

PORTLAND CEMENT.

# CONCRETE FIRE-PROOF SLABS.

For Internal and External Walls.
As cheap as any other, with the following advantages :—

**ECONOMY OF SPACE, GOOD KEY FOR PLASTER TILING, ETC., NO PLUGGING, AND SETTING COAT OF PLASTER ONLY REQUIRED.**

*For Particulars and Prices apply to :*

**THE ACTON CONCRETE PATENT PARTITION CO., 1909, Ltd.,**

Telegrams: "KONKREET, LONDON."
Telephone: 6294 AVENUE.

**63, CORNHILL, LONDON, E.C.**

# THE OFFICE FOR OFFICERS.

**LIFE ASSURANCE.** Specially designed for the Services.
**CONVENIENTLY PAID FOR** by Bankers' Orders (Monthly Premiums if desired).
**NO MEDICAL EXAMINATION** up to £500, in ordinary circumstances.
**LOANS AND SURRENDER VALUES.** Liberal and easy conditions.
**EXCEPTIONALLY GOOD TERMS** for War Risks and Foreign Residence.

Call or write for new Service Prospectus.

**Royal Exchange Assurance,** (Incorporated 1720.)
**West End Office: 44, PALL MALL, S.W.**

Digitized by Google

# THE ROYAL ENGINEERS JOURNAL.

Vol. IX. No. 6. JUNE, 1909.

## CONTENTS.


| | PAGE. |
|---|---|
| 1. **Staff Rides and Manœuvres.** By Lieut.-Col. H. S. JEUDWINE, R.A. (*With Photos*) | 417 |
| 2. **A Graphic Method for Calculating Field Suspension Bridges.** By Capt. C. E. P. SANKEY, R.E. ... ... ... ... ... | 433 |
| 3. **Unstable Territorials of Imperial Rome, Circa 200 B.C.—100 A.D.** By Col. O. E. RUCK, late R.E. ... ... ... ... ... | 437 |
| 4. **Progress in the Manufacture, Testing, and Employment of Portland Cement.** By J. G. BAXTER, Esq., F.C.S. ... ... ... ... ... | 439 |
| 5. **The R.E. Headquarter Mess** (*continued*). By Lt.-Col. B. R. WARD, R.E. ... | 455 |
| 6. **Memoirs:**—Lieut.-General Sir Richard Hieram Sankey, K.C.B. By 'H.M.V.' ... | 461 |
| Major Percy Braybrook Molesworth, R.E. By Capt. P. ROBINSON-EMBURY, late R.E. ... ... ... ... ... | 475 |
| 7. **Transcript:**—The Training of the 7th Engineer Regiment of the French Army. (Translated from the *Memorial de Ingenieros* by 'M.') ... ... | 477 |
| 8. **Reviews:**—*The Life of Major-General Sir John Ardagh.* By SUSAN, COUNTESS OF MALMESBURY (LADY ARDAGH) ... ... ... ... | 481 |
| *The Historical Records of the Fifth (Royal Irish) Lancers.* By Major W. T. WILLCOX, 3rd Hussars, late Captain, 5th Lancers. (Lieut.-Col. B. R. WARD, R.E.) ... ... ... ... ... | 486 |
| *Sanitary Engineering.* By MOORE & SILCOCK. (Lieut.-Col. J. WINN, late R.E.) ... ... ... ... ... ... | 487 |
| *Practical Arabic Grammar* ... ... ... ... | 488 |
| 9. **Notices of Magazines** ... ... ... ... ... ... | 489 |
| 10. **Correspondence:**—Railway Signalling. By Lieuts. G. C. V. FENTON and W. G. TYRRELL, R.E. ... ... ... ... ... | 494 |


CHATHAM:
ROYAL ENGINEERS INSTITUTE.
TELEGRAPHIC ADDRESS: SAPPER, CHATHAM.
AGENTS AND PRINTERS: W. & J. MACKAY & CO., LTD

PRICE: 1s. 6d. POST FREE. ANNUAL SUBSCRIPTION: 15s. PAID IN ADVANCE.

Digitized by Google

THE MODERN ROOFING MATERIAL,

# "ETERNIT."

ROOFING SLATES.

SHEETS FOR WALLS AND CEILINGS.

INDESTRUCTIBLE,
LIGHT,
ARTISTIC,
ECONOMICAL,
WEATHERPROOF.

Weight, 22 lbs. Laid.

## G. R. SPEAKER & CO.,

**Engineers & Contractors to H.M. Government,**

**29, MINCING LANE, E.C.**

WIRE—"ETRASHEET." 'PHONE—CENTRAL 13174.

## HAWKES & CO., LTD.,

TAILORS AND MILITARY OUTFITTERS, CAP AND ACCOUTREMENT MANUFACTURERS,

14, PICCADILLY, LONDON.

*Patronized by many Officers of the Royal Engineers.*

Telephone No.—East 53. Telegraphic Address:—"Constructive Ironworks, London."

## MATTW. T. SHAW & CO., Ltd.,

**MILLWALL, LONDON, E.**

**CONSTRUCTIONAL STEELWORK,**
**FRAMED BUILDINGS, BRIDGES, ROOFS, Etc.**

Large Stocks of Joists, Channels, Angles, Tees, Flats, Plates, Chequers, Rounds, Squares, Rivets, Bolts, Galvanized Sheets, etc., etc.

**VERY PROMPT DELIVERIES GUARANTEED.**

Digitized by Google

Telegrams—"GUNDRADA, LONDON." Telephone—4716 Gerrard.

Fire, Theft and Burglary *(Combined)*.

THE ARMY, NAVY AND GENERAL ASSURANCE ASSOCIATION, LIMITED

HEAD OFFICE:- 217, PICCADILLY (CIRCUS), LONDON, W.

Chargers, Hunters, Marine Risks.

# The "Professional" Policy
. of .
# Accident and Disease Insurance

Is Specially adapted for Military and Naval Officers serving in ANY PART of the WORLD, and now covers 30 Specified Diseases.

**Revised Prospectus of Extended Benefits on application—**

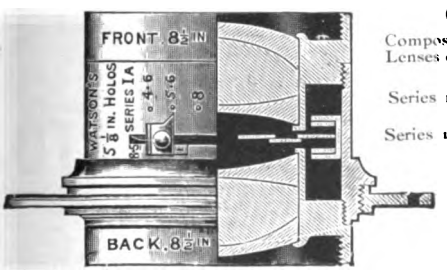
**217, PICCADILLY (CIRCUS), LONDON, W.**

## Surveying and other Scientific Instruments.

**C. F. CASELLA & CO.,** Instrument Makers to the British and all Foreign Governments, will be pleased to send their Price Lists, and to give quotations or other assistance to Officers requiring Scientific Instruments for Survey or other work.

**11-15, Rochester Row, Victoria Street, London, S.W.**

## THE FINEST PHOTOGRAPHIC LENS
— IS —
# THE HOLOSTIGMAT




*(WATSON CONRADY SYSTEM).*

Composed of two Anastigmatic and Achromatic Single Lenses of perfect correction for use as separate Lenses.

MADE IN THREE SERIES.

Series 1.—Aperture f6 Components f11·5. A perfect Lens for universal use.

Series 1A.—Aperture f4·6. Components f8·5. For rapid work in dull weather.

Series W A.—Aperture f11. Components f16. The ONLY convertible wide angle Lens made.

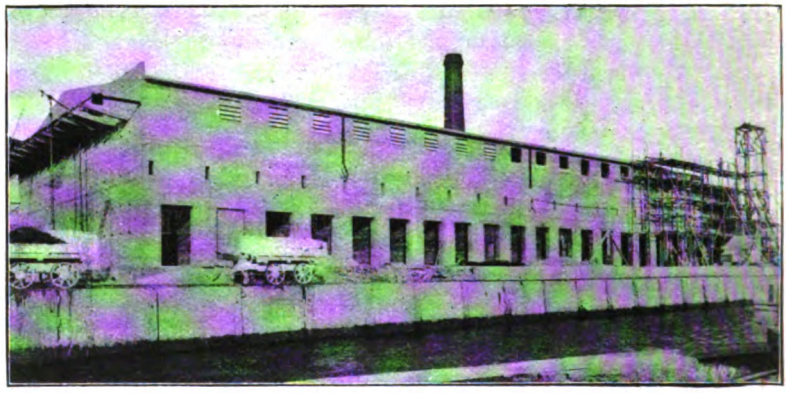
Price List sent FREE, on application by—

**W. WATSON & SONS, Ltd.,**
313, HIGH HOLBORN, LONDON.

Digitized by Google

# EXPANDED METAL

## SYSTEM OF
## REINFORCED CONCRETE
## AND
## FIRE-RESISTING CONSTRUCTION.



EXPANDED STEEL CONCRETE CEMENT STORE FOR THE WOULDHAM CEMENT CO., LTD., WORKS, WEST THURROCK.

### Specialities:—

**CONCRETE REINFORCEMENT**; 3-in. mesh weights Expanded Steel for Foundations, Walls, Floors, Roofs, Bridges, Reservoirs, Sewers, Conduits, Hoppers, Silos, etc.

**LATHING FOR PLASTER**; Expanded Metal Lathing for Ceilings, Partitions, Exterior Walls, Steel Work Encasing, etc.

**MADE-UP GOODS**; Openwork Partitions, Fencing, Clothes and Tool Lockers, Machinery and Tree Guards, etc.

*Full particulars on application to:—*

## THE EXPANDED METAL CO., LTD.,

**YORK MANSION, YORK ST., WESTMINSTER, S.W.**

**Telegrams:—"DISTEND, LONDON."** **Telephones:—819 Gerrard; 1514 Victoria.**


Digitized by Google

# PATENT VULCANITE ROOFING

FOR

FLAT ROOFS, CONCRETE ROOFS
AND WOOD ROOFS.

## ROOF TANKS

FOR

SWIMMING-BATHS, RESERVOIRS, BRIDGES.

**EFFICIENT AND ECONOMICAL.**

**For Waterproofing Existing Faulty Concrete and Asphalte Roofs.**

Will give with the movements of the building due to settlement, vibration, and expansion and contraction, and is guaranteed for long periods.

Special surfaces can be provided to the Vulcanite covering to meet any special requirements.

*Full particulars on application to:—*

**VULCANITE, LIMITED, 118, Cannon St., London, E.C.**
**Laganvale, Belfast,** and at **MANCHESTER.**

(Also Manufacturers of VULCANITE and BITUMEN Sheetings for the Sloping Roofs of Light Buildings, and for use as a Damp-proof Course).

# BULLIVANT & CO., Ltd.,

Manufacturers of

## *STEEL WIRE ROPES*

FOR

CRANES, LIFTS, HOISTS, SUSPENSION BRIDGES, HAULING, Etc.

**DURABLE AND RELIABLE.**

Contractors for . . . .

## AËRIAL ROPEWAYS

Specially designed for conveying Stores, Munitions, etc., across Rivers, Ravines, etc. Can be quickly and easily erected and dismantled. Suitable also for conveying Passengers.

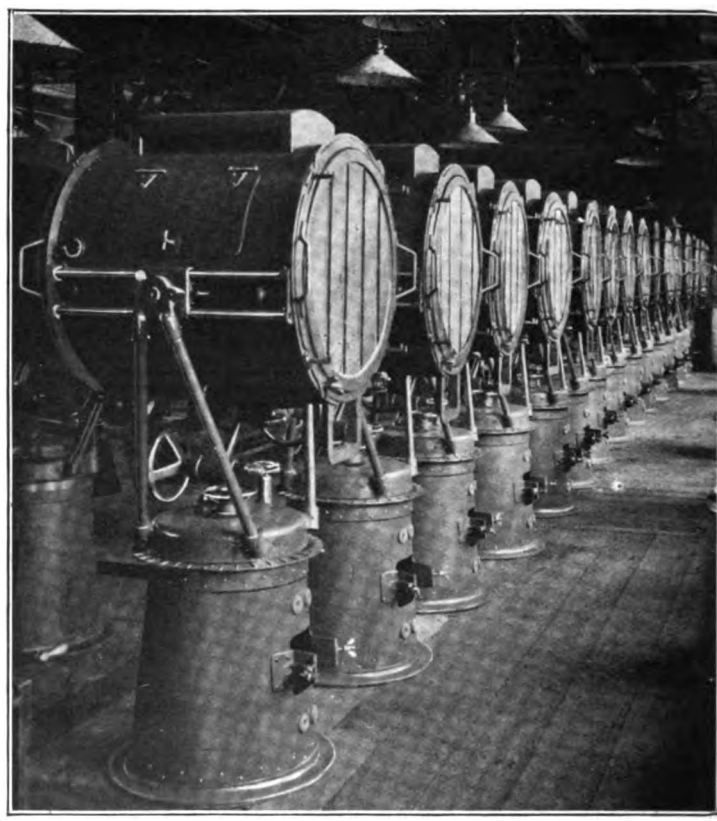
**BLOCKS, PULLEYS, TACKLE, AND ALL WIRE ROPE APPLIANCES.**

Regd. Office, **72, Mark Lane, London, E.C.**
Works, **Millwall, E.**


Digitized by Google

# Siemens Searchlight Projectors.

**MADE IN ALL SIZES FROM 25 cm. to 200 cm.**



**24-inch Light-weight Projectors.**

Part of a Recent Contract for H.M. Ships.

Projectors can be fitted with Siemens Patent Horizontal Automatic and Hand Lamp, or Horizontal Lamp for hand feed only. Mirrors of the metallic or glass parabolic type. Single or double Dispersing Lenses. Iris Diaphragm Shutter or Venetian Louvred Signalling Shutter. Electric Control is fitted for Fortress, Battleship, and other use, if desired.

**Full Particulars on Application to M Department.**

## SIEMENS BROTHERS DYNAMO WORKS LTD.,

**Caxton House, Westminster, S.W.**

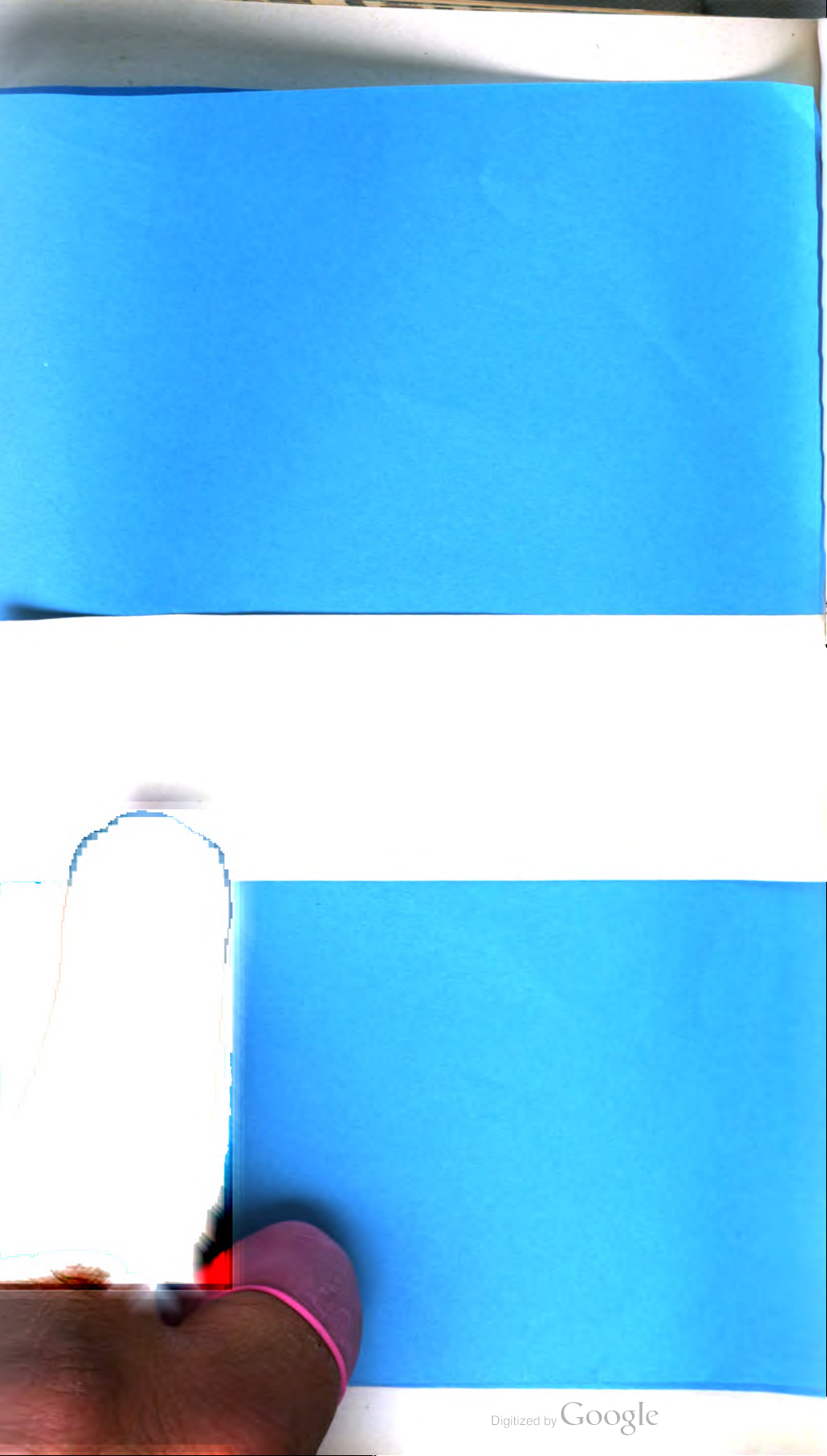
Telephone : GERRARD 8011. Telegrams : "SIEMBRALOS, LONDON."


Digitized by Google

## ERRATUM.

In the Map illustrating "Swallow Holes," published with the *R.E. Journal* for May, *for* "Scale: six inches," etc., etc., *read* "Scale: three inches," etc., etc.

Digitized by Google



Digitized by Google

# CONTENTS.


PAGE.

1. STAFF RIDES AND MANŒUVRES. By Lt.-Col. H. S. Jeudwine, R.A. (*With Photos*) ... ... ... ... ... ... ... ... ... ... 417

2. A GRAPHIC METHOD FOR CALCULATING FIELD SUSPENSION BRIDGES. By Capt. C. E. P. Sankey, R.E. ... ... ... ... ... ... ... 433

3. UNSTABLE TERRITORIALS OF IMPERIAL ROME, CIRCA 200 B.C.—100 A.D. By Col. O. E. Ruck, late R.E. ... ... ... ... ... ... ... 437

4 PROGRESS IN THE MANUFACTURE, TESTING, AND EMPLOYMENT OF PORTLAND CEMENT. By J. G. Baxter, Esq., F.C.S. ... ... ... ... ... ... 439

5. THE R.E. HEADQUARTER MESS (*continued*). By Lt.-Col. B. R. Ward, R.E. ... 455

6. MEMOIRS :—

Lieut.-General Sir Richard Hieram Sankey, K.C.B. By 'H.M.V.' ... ... 461

Major Percy Braybrook Molesworth, R.E. By Capt. P. Robinson-Embury, late R.E. ... ... ... ... ... ... ... ... ... ... 475

7. TRANSCRIPT :—

The Training of the 7th Engineer Regiment of the French Army. (Translated from the *Memoriat de Ingenieros* by 'M.') ... ... ... ... ... 477

8. REVIEWS : --

*The Life of Major-General Sir John Ardagh.* By Susan, Countess of Malmesbury (Lady Ardagh) .. ... ... ... ... ... .. 481

*The Historical Records of the Fifth (Royal Irish) Lancers.* By Major W. T. Willcox, 3rd Hussars, late Captain, 5th Lancers. (Lt.-Col. B. R. Ward, R.E.) ... ... ... ... ... .. ... ... ... ... 486

*Sanitary Engineering.* By Moore & Silcock. (Lt.-Col. J. Winn, late R.E.) 487

*Practical Arabic Grammar* ... ... .. .. ... ... ... 488

9 NOTICES OF MAGAZINES :—

*Journal des Sciences Militaires.* By Lieut. H. L. Woodhouse, R.E. ... 489

*Le Bulletin.* By 'E.R.' ... ... ... ... ... ... ... . . 490

*Militärische Presse.* By Capt. R. Walker, R.E. ... ... ... ... 491

*Revue du Génie Militaire.* By Capt. J. E. E. Craster, R.E. ... ... ... 493

10. CORRESPONDENCE : —

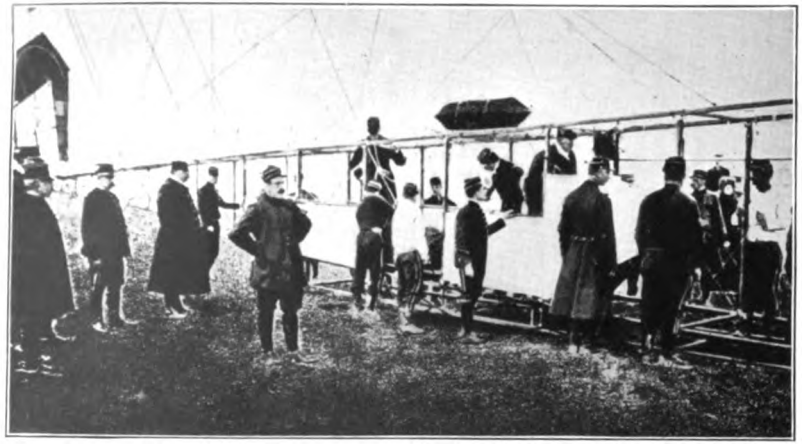
Railway Signalling. By Lieuts. G. C. V. Fenton and W. G. Tyrrell, R.E. ... 494


*Authors alone are responsible for the statements made and the opinions expressed in their papers.*

Digitized by Google

Digitized by Google

Digitized by Google



Car of a Dirigible Balloon.

Gun Limber used as Field Observatory.

Digitized by Google

# *STAFF RIDES AND MANŒUVRES.*

*A Lecture given at the S.M.E. on 7th January*, 1909, *by* LIEUT.-COLONEL H. S. JEUDWINE, R.A.

THE regulations regarding staff rides and manœuvres which at present are to be found in Chapter VII. of *Combined Training* are undergoing revision, and will shortly be republished, with additions and amendments, in the shape of a separate manual, entitled *Training and Manœuvre Regulations*. In this volume the designation "Staff Ride" is altered to "Staff Tour," and "Regimental Tours" are called "Regimental Exercises." I propose therefore to refer to them under the new nomenclature.

Staff tours and manœuvres, as means of training officers, are complementary to each other. Each has its peculiar advantages and limitations. The opportunities which the one presents are not always to be found in the other, and at the same time different drawbacks attach to each.

In a staff tour it is possible to present exercises in strategy and in grand tactics, involving the handling of large forces and their movement and disposal over a wide area. The bulk of the administrative work which, in the case of actual forces, would be necessitated by this, can be practised in a manner approaching to the conditions of war, and untrammelled by the fictions which during manœuvres we are compelled to adopt by peace establishments of men, horses, and vehicles, and by the absence of arbitrary powers over means of communication, inhabitants, etc. For instance, in a staff tour we can, in imagination, assume control of a railway system, or of telegraphs, impress vehicles, requisition supplies, enforce billeting, etc., and the fact of our doing so will compel us to practise the systems of control by which such measures would in war require to be regulated.

But exercises in tactics, although possible to some extent with liberal aid from the imagination, are not always convincingly presented in staff tours. The necessity for mutual co-operation and the penalties which follow from its absence are not clearly demonstrated. Estimates of time and space are apt to be optimistic. There is a pleasant sense of irresponsibility, which is apt to result (on paper) in the execution of great feats of marching, in lightning entrainments, and in the magical evolution of impregnable defences in the absence

Digitized by Google

of tools, of materials, and even of men to use them Although the exercise of the imagination is to some extent a necessity at manœuvres also, they are attended by conditions of reality sufficient to exert a sobering influence on those responsible for the issue of orders. One hesitates to invite troops to undertake record marches or to do without sleep or food, even in the glorious cause of Redland or Blueland, when the order has to be conveyed to a materialized Red or Blue General or Commanding Officer, instead of to the accommodating and uncomplaining General X. or Colonel Y., who are such delightful comrades on a staff tour.

In addition to the advantage which manœuvres possess of curbing undue impetuosity on the part of the staff, they afford training in command and in initiative to regimental officers and non-commissioned officers, and in the physical labour of war to the rank and file.

I propose to refer first to staff tours, next to regimental exercises, and finally to manœuvres.

## Staff Tours.

In dealing with staff tours and with regimental exercises I do not intend to attempt anything approaching a thorough treatment of the subject, but will try to confine myself mainly to new points and those which particularly touch officers attending them, rather than to those affecting the duties of the directing staff.

The object of staff tours is defined as being to train the higher commanders, staff officers, and those who may be appointed to command, or to the staff.

*Schemes.*—The first thing is the preparation of the scheme. The scheme is embodied in general and special ideas. The general idea contains information which in war would be within the knowledge of both combatants. When staff tours are double it is common to both sides. Special ideas contain information which would be in the possession of one combatant only. In the case of double tours there is a separate special idea for each side.

It is the function of the general idea to create, as it were, the atmosphere surrounding the imaginary operations, so that an officer who has thoroughly absorbed it may be imbued with the same knowledge and ideas as he would possess in similar actual circumstances, and may look at events in the same light. The mental attitude of anyone in similar circumstances in actual war is the result of an unconscious appreciation of hundreds of facts, each small in itself, which have presented themselves to him in succession during many months or even years which have preceded the actual events of the present moment. It is the result of what he has read, heard, or seen day by day. Of course all these facts cannot be recorded in any general idea, but it is worth attempting to produce the general effect of them,

Digitized by Google

or an approach to it. For this reason the general idea of a staff tour may be a document of some length. But length has no virtue in itself, and there is nothing gained by the addition of a single line if that line does not help to make the situation more vivid.

The special idea sets out the data for the immediate problem to be solved, the position and distribution of the troops under the commander's authority, and the circumstances of the moment at which operations commence. It contains intelligence such as the commander might possess in war concerning the strength, distribution, and recent action of his opponents. This intelligence need not be in the shape of exact information, since exact information on such points would as a rule be lacking in war. It may take the shape of supposed intelligence, obtained from inhabitants or from reconnoitring troops, which would naturally often be wanting in completeness. Or it may consist wholly or in part of reports, not necessarily entirely trustworthy, from which certain inferences may be drawn. When such reports form part of the intelligence contained in a special idea, they should not be intended by the composer of the special idea to carry more weight than it would be fair to attach to them in war; nor should the reader be led into attaching more value to them than he would be justified in doing in real life.

The scheme for a staff tour may be purely imaginary, or it may be based on a historical example. Whichever plan is followed, care must be taken that in its main features it is strategically and tactically sound, in order that there may be no danger of inculcating false principles or creating impossible situations. But it does not follow that all its details need be immaculate. The greatest commanders have made mistakes in war, and these may furnish episodes on which instructive schemes may be built up. One advantage of a historical basis for a scheme is that it stimulates interest in the campaign from which the scheme is taken, and often leads to the study of military history on the part of officers who might otherwise have neglected it.

One difficulty which is very generally met with in devising a sound scheme for a staff tour is that, owing to the limit which must be placed on the number of officers who can be employed, the forces actually dealt with must generally be a comparatively small part of the total forces which would be engaged in similar operations; that is the force actually dealt with must be of the nature of a "detachment." When this is the case, a sound strategical reason for the employment of a detachment must be apparent in the general idea.

Another difficulty is the adaptation of the scheme and the ground to each other; or when the scheme is based on history, the selection of ground, conveniently situated, which bears a sufficiently strong resemblance to that on which the historic operations took place. In the process of adapting scheme and ground to each other it may be

Digitized by Google

necessary to subject physical features to imaginary changes, but in this case alteration of features which are included in the area of tactical operations should be avoided, as such action robs the scheme of all reality, and alterations which are made should not bring too great a strain on the imagination, as is sometimes the case when continents are submerged, or large islands called up from the vasty deep, or oceans so located that rivers run out of instead of into them.

Among possible schemes are some of a more or less special nature, such as those dealing with the attack and defence of land or coast fortresses, with embarkations and disembarkations, with mountain or bush warfare.

The attack and defence of fortresses offer special opportunities for the practice of the co-operation between artillery and engineers, which would be a special necessity of such operations. The utilization of such schemes as a basis for staff tours is a somewhat recent development. The first staff tour of this kind, as far as I am aware, was that held in this command (Chatham) under General Scott as a preliminary to the siege operations of 1907. Others have been held at Shoeburyness and elsewhere. The problems arising in connection with such staff tours are in some respects peculiar, and are made more difficult by the fact that official literature dealing with the subject is rather scarce.

An important advantage of schemes into which both land and sea operations enter, such as those connected with the attack and defence of coast fortresses, or with embarkation or disembarkation, is that they offer the opportunity of practising co-operation with the Royal Navy in such undertakings. This is of particular value to the army of an insular power which cannot make itself felt in offence save by virtue of very complete co-operation of this kind. It is all the more important to practise this co-operation occasionally by means of staff rides, because to do so at manœuvres involves almost prohibitive expenditure, as in the case of even the small force disembarked on the Essex coast in 1904.

It is not everywhere that ground can be found suitable for schemes dealing with mountain warfare, but, at home, Wales and Scotland offer opportunities for solving realistic problems on the ground, and several successful mountain staff tours have been held in these districts. Opportunities for practising bush warfare are practically non-existent at home.

General and special ideas will generally be issued a fortnight or three weeks before the tour is to commence, in order to allow officers to study them and to become thoroughly conversant with the general situation. If the scheme is based on a historical example a longer time may be necessary, in order to give opportunity for a study of the campaign.

Digitized by Google

*Appreciations.*—Appreciations will be called for from all officers, or at all events from commanders of forces, to be handed in a few days before the tour commences.

The object of appreciating a situation is to arrive by consideration of all the factors at the best course to adopt. Although the term "appreciation" is generally applied to the document drawn up at a staff tour or on manœuvres for submission to a director, appreciations are far from being limited to such uses. Whenever a strategical or tactical decision has to be made, it is necessary first to *appreciate* the situation. The form of, and the time available for an appreciation vary with the situation. An appreciation is required before the commencement of a campaign with a view to deciding on the strategical action to be taken. Such an appreciation would be a document of considerable length, prepared in anticipation of the outbreak of war. An appreciation is however equally required whenever a company of infantry suddenly finds itself in touch with an enemy. But in this case the appreciation would be reasoned out almost instinctively in the head of the company commander, and his course of action would be selected in a few minutes or perhaps even a few seconds. The kind of appreciation that we generally have to deal with in a staff tour is intermediate between these two, and is valuable as training for both of them. It is intended to accustom us to look all round a situation, not only on one side of it; to seize on the salient points, and to come rapidly to a decision after weighing one point against another. Whether the arguments are committed to paper, or whether the process is a mental one—and in the latter case whether it is conscious, or unconscious and instinctive—the object of an appreciation is the same—to arrive at the best course of action.

It has been decided that it is undesirable to lay down hard-and-fast rules as to the form which an appreciation should take. A great deal must depend on the nature of the problem and of the factors governing it. At the same time most officers, until they have gained experience, require guidance in the arrangement of their ideas, so that the result may be a logical and intelligible document, and so that the course of reasoning which has led to the recommendations may be clearly stated.

In the *Training and Manœuvre Regulations* certain headings are given with the object of assisting officers who through inexperience are in want of guidance; but it is clearly stated that there is no intention of fettering those who are not in want of assistance.

The following headings will generally be found suitable :—

(*a*). The distribution and relative numbers of the opposing forces.

(*b*). The object to be attained.

Digitized by Google

(*c*). Other factors which influence the situation, *e.g.*, character of the opposing commander and *morale* of the troops on both sides; politics; topographical and climatic conditions (which influence time and space); supply and transport, railways and communications; bases and reinforcements.

(*d*). The courses of action open to the enemy and to our own forces, their relative advantages and disadvantages.

(*e*). The plan recommended for adoption.

The main object to aim at is to seize on the dominant factors of the situation, and to turn them to account so as to gain the initiative and force the enemy to subordinate his actions to your own. In exceptional cases the nature of the situation or the orders received may preclude taking the initiative, but a purely passive attitude is very exceptionally permissible, and when such an attitude is recommended it must be clearly justified in the appreciation. The style should be simple, concise, and direct, and care should be taken that the recommendations are justified by the arguments. The whole document should be as brief as is compatible with clearness.

*Work of Officers attending Staff Tours.*—The officer in each party who represents the commander of the force will usually allot to the officers under him their daily tasks. These tasks should consist of work required to enable him to form his plans and to maintain, protect, move, and fight his force. As a rule each officer will be supposed to be occupying a definite position in the force as a commander, a general or administrative staff officer, a departmental officer, or in command of a unit. The work he is required to perform should be related to the position he occupies. Administrative work is not less important than that connected with operations, and should be carried out with as near an approach to reality as the time and the number of officers available admit.

Out-of-door work may include reconnaissance of and reports on :—

Ground, with a view to security, attack, or defence; localities such as villages, bridges, posts, or depôts on lines of communication, with a view to defence; rivers, hilly or mountainous areas, etc., as to their value as military obstacles; roads, rivers, railways, telegraph lines, as means of communication; railway stations, as to their facilities for dealing with military traffic; streets and roads, with a view to the regulation of traffic at points where it is likely to become congested; harbours, docks, and coast lines, with a view to embarkations and disembarkations; billets, camps, bivouacs, and forming-up places; sites for and arrangements of depôts and hospitals; areas, with a view to accommodation and supplies.

The indoor work, if officers are detailed to certain appointments,

Digitized by Google

will naturally be that which those appointments would in each case provide for. If officers are not so detailed, work of a useful and relevant nature must be set by the assistant director.

The indoor work may consist of:—

Writing operation orders; drafting routine and standing orders; keeping staff diaries and intelligence reports; writing despatches; working out and drawing up time-tables for movements by rail; calculations of tonnage required for movements by sea; arrangements for entrainment, embarkation, or disembarkation; organization of a system of field intelligence; arrangements for the evacuation of sick and wounded; replenishment of ammunition and supplies; the organization of lines of communication; arrangements for the requisitioning of supplies, transport animals, vehicles, and stores; collection and distribution of requisitioned supplies, etc.; replacement of *personnel*; organization of civilian labour; disposal of military prisoners; military administration of conquered territory.

In writing orders officers should be restricted to approximately the same time as would be available in similar conditions on service. It is no use being able to write admirable orders unless they can be written quickly. Delay in writing orders means delay in issuing them, and the hour or half-hour lost at headquarters is never regained, and may mean a loss of that amount of time in getting a force into motion or commencing some important operation.

With regard to administrative problems, it is only somewhat recently that stress has been laid on the necessity for their consideration at staff tours. Formerly staff tours dealt almost exclusively with the work immediately connected with fighting, and, although bivouacs and moves by rail were studied to some extent, this was practically the case only with reference to the fighting troops. One of the causes of this was no doubt the absence of authoritative instructions. But *War Establishments* now contain much fuller tables than formerly, and the *Field Service Pocket Book* contains a great deal of administrative information, which, until it was published, was difficult of access. Part II., *Field Service Regulations*, when published, will, contain still fuller particulars. Attention has recently been directed by the Chief of the General Staff to the necessity for studying all problems connected with the maintenance of the Army.

One of the most difficult problems is undoubtedly that of billeting. In this country we have not the power to billet troops on the inhabitants generally, as Continental nations have, and consequently, although we should no doubt have to use this means of accommodation and supply largely if operating on the Continent, we have no means of actually practising it in peace. Unless we have practised ourselves in billeting, great confusion is likely to arise when we attempt such a thing in war, and it is therefore most necessary that we should endeavour to prepare ourselves for such a contin-

Digitized by Google

gency. The maintenance of a large force in billets is a very complicated business, but it is thoroughly understood on the Continent and carried out with the utmost smoothness at manœuvres.

Then, again, the magnitude of the organizations in the rear of an army is not always appreciated, or the tremendous influence which their efficiency or otherwise exerts on the offensive powers of the fighting troops. There are some excellent diagrams in the *Field Service Pocket Book* to illustrate these organizations, which show clearly how complicated the machinery in rear of an army unfortunately is. It is obvious from these diagrams how much administrative arrangement in connection with the supply of food, forage, and ammunition, and the treatment and evacuation of sick and wounded, there is scope for in a staff tour, even if we go no farther back than the advanced depôt. Except in a very large staff tour, or one held expressly for the purpose of dealing with lines of communication problems, we seldom have the opportunity of going into the work which is required in rear of the advanced depôt; but the existence of all the organizations and establishments which must be present in rear of the fighting troops, and of the lines which stretch away behind them, should never be lost sight of.

We now come to

## Regimental Exercises.

The term "regimental exercise" is used in lieu of the term "regimental tour," which is the one used at present in *Combined Training*. The change in name emphasizes the fact that exercises of this nature may be carried out in close proximity to quarters, and do not necessarily involve a "tour."

Regimental exercises are defined as "Exercises in which regimental officers work out on the ground, under the guidance of a director, minor tactical and administrative problems, such as they may be called on to solve in war."

The director, who will be a field officer, will select the country, which must be within easy reach of the place at which the unit is quartered, and will prepare a scheme. The exercise will usually be limited to one day. It will, therefore, generally be on the lines of the exercises which are treated of in Chapter XX. of General Haking's book, under the heading of "One Day Exercises." In that book will be found excellent examples of two such exercises, fully worked out, which should be of the greatest use to anyone conducting or taking part in work of this kind.

Schemes and the nature of the work will vary according to the arm and to the rank of the officers to be instructed.

Infantry and field artillery and engineer officers may be exercised in schemes dealing with one or two battalions, from one battery to a brigade of artillery, and from a troop to a squadron of cavalry.

Digitized by Google

Cavalry and horse artillery officers may be given schemes dealing with from a squadron to a regiment, with a battery of horse artillery. To encourage co-operation and the exchange of views between officers of different arms, officers directing regimental exercises should secure the attendance of at least one officer of each of the other arms.

The director will go over the ground carefully, and will arrange a series of situations involving minor tactical operations varying from the handling of a troop, a section of artillery, or half a company up to that of a regiment of cavalry, a brigade of artillery, or a battalion, according to the rank and experience of the officers. Whether the operations of the whole, or only a part of the force be followed out on the ground, the action of those parts not actually handled will always be taken into account.

The director will prepare beforehand a written statement indicating the action of the enemy as far as it can be foreseen. Where this action depends on the measures taken by the officers under instruction, it must be improvised on the ground. The problems to be solved may be prepared beforehand ready for distribution to the officers, or they may be improvised on the ground as the outcome of developments brought about by the action of the officers themselves. To carry out a scheme successfully and to make it interesting the director should, if possible, be gifted with an imagination which will supply him with a mental picture of the battlefield, and fill it with minor but realistic detail. If he is weak in imagination he will do well to study the situation on the ground particularly carefully beforehand, and himself work step by step through the various operations that he intends to present to the officers, accounting to himself as he goes along for the action of each unit or body of the enemy—the actual fences their infantry will line, or buildings they will occupy, the position of their artillery and its line of retreat; where limbers and 1st line wagons will be placed; where machine guns will be posted; the action of their cavalry, and where their horses will be left if they act dismounted. In short, whatever cock-and-bull story his inspiration may present, he must ensure that it is "of convincing detail full," if it is to impress the officers with its reality.

The orders on which the force is to act, if not included in the special idea, will be issued the night before or on the way to the ground. The party will be divided into pairs or groups if necessary.

On arrival on the ground the first situation will be issued and officers directed to make any reconnaissances that may be necessary, make notes of the action they intend to take, and rejoin the director at a certain spot at a certain time. In making reconnaissances officers must confine themselves to ground which would be accessible in war, and must not traverse ground which is supposed to be under effective fire.

On re-assembling, each officer, or one from each group, will be called

Digitized by Google

on to report the action he has taken. The director will comment, and the situation will be discussed. The party will then proceed to the next situation. Each problem may occupy from one to one and a-half hours.

In discussing problems of this kind it may be as well sometimes to ask an officer what reports he has made to his superior commanders. Such reports are often of great importance. The art of making them tersely does not come easily to everybody, and it is worth reminding officers that they are required in war and must be practised.

## MANŒUVRES AND TACTICAL EXERCISES.

The *Training and Manœuvre Regulations* will also present some new features in respect of manœuvres.

I do not propose to go thoroughly into the subject of manœuvres, which would absorb a great deal more time than you would care to allow me. I will however endeavour to indicate what are likely to be the salient points of the new regulations.

*Manœuvres* are defined as operations between opposing forces, or against a skeleton force, in which the commanders are allowed freedom of action within the limits of the scheme.

*Tactical Exercises* are operations against a skeleton force whose commander's action is limited so as to allow the exercise to be carried out in accordance with the wishes of the officer directing the operations.

Operations may be held, with a special eye to one of the following objects :—

(1). Inspection, *i.e.*, to judge of the standard of training of the troops.

(2). Higher training, with a special view to affording opportunities of experience to commanders and staffs.

(3). To test the value of some theory or principle, or to practise some particular form of operation.

These will be carried out as manœuvres or as tactical exercises, as may be most suitable to the end in view.

The following special exercises may be carried out as opportunities arise :—

(*a*). Combined naval and military manœuvres—landings, attacks on defended ports, etc.

(*b*). Siege manœuvres.

(*c*). Mobilization exercises, such as the mobilization of a division or of a coast defence command.

(*d*). Exercises to test the administrative services, such as medical or transport arrangements, or the supply of food or ammunition.

Digitized by Google

It is always desirable to approach as closely as we can to war conditions in manœuvres. At the same time it is as well to recognize that there is a limit beyond which it is not desirable to go, especially in matters of supply, transport, and accommodation. In war we are not wholly dependent on what is carried with the army. If rations are not available, food can be obtained on requisition; if wagons break down, others can be impressed; if the weather is inclement, troops can be billeted in any available buildings. This is not the case in peace in England, and if all ranks are hungry, cold, and wet for days together, tactical lessons will not be laid to heart as they might be in happier circumstances. Besides, black and uncomplimentary headlines will appear in the newspapers, which will be full of the soldier's hardships and of demands for exemplary treatment of the culprit responsible. A voluntary army cannot afford to neglect the result of such occurrences. Besides, the financial expenditure necessary to equip even a small force with transport on a war scale is comparatively large, and money can only be found for it by refusing other demands which may be more important from a training point of view.

There is a point which seems at present to be attracting particular attention in all armies in connection with endeavours to lend reality to operations, viz., the subject of umpires and umpiring. It is only natural that this should be so. Recent progress in methods and material of war have all acted in the direction of making the umpire's task more difficult. The combined result of large armies, wide extensions, neutral-tinted uniforms, smokeless powder, cover, and concealed positions has been to make it extremely difficult for an umpire to discover what is going on at any distance, or even where troops are, and in what strength.

In the French, the German, and the United States Armies, among others, new instructions for umpires were in force at last year's manœuvres. The general tendency has been towards increasing the number of umpires and giving them more independence. The French in their grand manœuvres last year had no less than twenty-one general officers on the umpire staff.

There have been two principal complaints against our system of umpiring in the past. One was that umpires interfered too much, and the other that they interfered too little. The fact that these two opposite complaints have been urged against our system shows that there is something wanting in the regulations, or that they have been wrongly interpreted.

The duties of umpires may be said to be twofold, viz.:—

(1). To give such information to troops as they would obtain in war from shells and bullets.

(2). To give decisions when troops come into actual collision.

Digitized by Google

In order that umpires may be prepared in advance to appreciate situations as they arise they must make themselves fully acquainted before action with the general and special ideas; with the narrative of preceding operations, if any; and with the intentions and orders of commanders if possible of both sides, but at all events of the side to which they are attached. During an engagement, although they must avoid giving away the position of troops to their opponents before contact is established, they must ascertain, directly touch is gained, the dispositions and strength of opposing troops, and must as far as possible obtain and keep communication with the umpires attached to the opposing side. For this purpose their position will generally be well forward, where they can be in frequent personal conference with these umpires.

In order to carry out the first duty, that of giving information to the troops, they must know how the enemy's firing line and artillery are posted, what are their numbers, and what is the objective of their fire. It will then be possible for an umpire to say, for instance, to a commander in the firing line, "You are under a superior musketry fire from the wood on your right front and flank, and under heavy artillery fire from behind the ridge to your left front." It will then rest with the commander to take steps to obtain reinforcements or support sufficient to place himself more on an equality with his opponents before attempting to advance.

Great difficulty is now felt by umpires in appreciating the effect of artillery fire and assigning to it a fair value. This is due to long ranges and concealed positions, and the difficulty will be accentuated when smokeless blank for artillery comes into use, as it probably will this year. All the information that an umpire with advanced troops in the early stage of a battle gets concerning the disposition and objective of the opposing artillery may perhaps be the sound of a few guns a long way in his front. If he is fortunate enough at this early stage to meet an umpire of the opposing force he may perhaps learn something of what they are shooting at, but the probability is that this fortune will not befall him, and he will then have to resort to his imagination. If he thinks it reasonable to suppose that the guns are firing at the troops he is with, he should so inform the latter, in order that they may be obliged to adopt suitable formations. He may give them this information with full confidence, well knowing that, if he himself is ignorant, the accompanying troops at all events have no grounds for contradicting him.

Unless umpires use their imagination in this way, the effect of artillery is apt to be underrated at manœuvres and the importance of artillery support entirely neglected. The artillery gets disheartened, seeing that its best efforts are credited with no result, and the infantry care nothing whether the artillery supports them or not. Eventually neither takes any interest in what the other is

Digitized by Google

doing, and each fights its own battle independently, which is bad teaching for all concerned.

With regard to the second duty of umpires, that of giving decisions when troops come into collision — as in the case of an assault on an enemy in position — this will generally fall to the senior umpires of each side or the umpire-in-chief, but where tactical operations are spread over a comparatively wide extent of country, and especially when that country is enclosed, broken, or wooded, there will probably be numerous instances even in the early stages of a battle where small bodies will come into close contact, and where the intervention of junior umpires will be necessary to prevent unreal situations being created, and their effect being allowed to influence the operations at large. In such cases junior umpires must act with decision, and while confining their action to the minimum of interference in the position or movements of the troops, they must endeavour to prevent the encounter having a false effect on the general course of the engagement.

For instance, suppose in the earlier stages of an attack on a position local opposition is encountered by some part of the attacking force from defenders' troops occupying an advanced post from which flanking fire can be brought to bear on portions of the attack. Possibly the defenders of the post may be forced to evacuate it by envelopment, but if they do not do so of their own will they must be given credit for the effect which they produce by hanging on, and if they decide to do so to the last nothing short of an actual local assault by a portion of the attacking force should force them to evacuate. It will be for the junior umpires on the spot to watch carefully the conduct of operations on both sides; to see that the approach and assault, if carried out perfunctorily, and in a way which could not have reasonable chances of success in war, are not allowed to succeed; and on the other hand to see that the local resistance of the defender is credited with no greater result than could be expected in view of his strength and preparation for defence, and is not prolonged in a way which would be impossible in war. A wrong decision in either of these directions, or the absence of a decision, may have a lasting false effect on the progress of the whole operations, either by allowing the general attack to be too quickly driven home, or by suffering weak local opposition to act unduly as an impediment to the advance of greatly superior forces. Similar instances of local collisions needing quick decisions are of frequent occurrence in encounter battles, in which the opposing sides meet without opportunities of complete reconnaissance, and each side is striving to obtain the initiative. A golden rule is that a prompt decision, even if it is faulty owing to want of full information, is better than a correct one long delayed.

Digitized by Google

The following points should receive consideration in judging of the conduct of an attack :—

(1). The choice of fire positions and the manner in which they are approached and occupied.
(2). The use made of the tactical features of the ground and of cover.
(3). The fire preparation previous to the assault.
(4). The co-operation of the artillery.
(5). Superiority of force.
(6). The frontal or enveloping nature of the attack.

In judging of the conduct of the defence the following are the chief points to pay attention to :—

(1). The distribution of the troops.
(2). Whether the position has been artificially strengthened.
(3). The field of fire.
(4). The co-operation of the artillery in the decisive stages of the fire fight.
(5). The use made of reserves for counter-attack.

In coming to a decision as to the success or failure of an attack, due credit should always be given to the moral influence of offensive action. It is desirable to impress on troops and commanders the advantages which are gained by initiative and the offensive spirit, and for this reason, unless the attackers are relatively very weak, or the attack has been misconducted, the attacking side, if there is any uncertainty as to the result, should always have the benefit of the doubt. There is one tendency—sometimes observable at manœuvres—which should be carefully guarded against, viz., the inclination to take into consideration the value of reserves which are not firing. Only the troops which are actually engaged have any tactical value. The presence of others must be neglected as far as the tactical situation is concerned.

When an assault has been delivered, effect will be given to the umpire's decision by ordering the defeated troops to retire behind the line of their nearest supports. If there are no supporting troops the losers will be ruled out of action for a definite period, and will be ordered to withdraw to a specified locality before re-commencing operations. But so that their instruction may not be too much interfered with the period should be as short as possible.

In cavalry encounters, where shock action is used, the *moral* of the defeated side would suffer severely, and in such cases it will generally be necessary to order them to retire from the field for a

Digitized by Google

considerable period of time in order that the winners may have the opportunity of reaping full advantage from their victory.

The distribution of umpires is a subject which deserves careful consideration. The director of the manœuvres is *ex-officio* umpire-in-chief, and under his authority a senior umpire and a staff of umpires will usually be allotted to each side. The umpires may be allotted to their various duties under the authority of the director, but they will usually be so allotted in large manœuvres by the senior umpire on each side. There are two systems of distributing umpires—they may be allotted to certain units or to certain areas of ground. The director will usually decide which of these two systems is to be followed, but sometimes a combination of the two systems may be convenient, or it may be found that in certain operations one system gives the best result, and in certain other operations the other system is most convenient. Both systems have been exemplified in our own operations and in foreign manœuvres.

When umpires are allotted to units, one will usually be required with each regiment of cavalry, brigade of artillery, and battalion of infantry. These would be divided into groups, each under the senior, and the natural grouping is by brigades in the case of cavalry and infantry, and by divisions in the case of artillery. If enough officers are available it will probably be of advantage to attach an extra umpire to the headquarters of each cavalry and infantry brigade, and to the divisional artillery. This umpire would be the senior of the group, and the control of the umpires in the group would be vested in him. Where units remained long in reserve, the senior umpire of the group would temporarily re-allot the umpires attached to them to other units which might be closely engaged, or to certain areas where the combat was hottest. This facility for local re-allotment of umpires is particularly useful in close country, where several distinct minor encounters may take place simultaneously. As the senior umpire of a group would be in a position to know the intentions of the brigade or other commander to whose staff he was attached directly they were formed, he should be able to provide for any contingency which might suddenly arise.

All reports from umpires with units should be made to the senior of the group, and should be collated by him and despatched either at stated intervals or on the termination of a day's operations to the senior umpire of the side. For this purpose he should be furnished with one or two bicycle orderlies. By this means the second possible disadvantage of the unit system can be obviated.

There will generally be a phase in the operations at the beginning of the manœuvres when the cavalry of the opposing forces are in contact, but the infantry are far apart. In this stage it will be necessary temporarily to withdraw umpires from the field artillery and infantry, and largely to increase the numbers with the cavalry, so as

Digitized by Google

to provide for the regulation of small affairs of squadrons and patrols, which may be of frequent occurrence in the early phases of the cavalry encounter.

I do not think I can conclude these observations on umpiring better than by quoting the remarks of Major March, of the United States Field Artillery, Director of the U.S. Camp of Exercise at Fort Riley in 1908, in his report on that camp.

He says: "There has been in former camps some complaint of the lack of rank of umpires. I am convinced that the main cause for complaint, if any appears, is not so much lack of rank as lack of fitness for such work, and that in this camp the rulings of officers met with respect according to whether they were deserved, regardless of the rank of the umpire. Duty as an umpire at a manœuvre camp is not appropriate for a man who is out for a jaunt. It requires hard work, and officers who do well should have credit for it in their efficiency reports."

Digitized by Google

# *A GRAPHIC METHOD FOR CALCULATING FIELD SUSPENSION BRIDGES.*

*By* Capt. C. E. P. Sankey, R.E.

The case of a field suspension bridge, where the piers on either side are the same height and where the cables are loaded throughout their entire length, is simple, and the calculations necessary to find the maximum tension in the cables and the lengths of the slings are fully explained in *Military Engineering*, Part III., para. 189, *et seq.*

The case in which the piers are of unequal height, but where the cables are still completely loaded, is almost as simple, and the modifications in the usual calculations are also explained in the paragraphs referred to above.

The problem however is not so easy when on one or both sides there are unloaded lengths of cable, strained over piers of possibly different heights, or attached to anchorages at possibly different levels. In such a case the simplest method of procedure appears to be a graphic one, whereby the data of the curve of the cable may be obtained and the necessary calculations then made as in the normal case.

Certain assumptions are made in the textbook, in order to simplify the considerations that govern the curve in which the cables of a suspension bridge hang. These assumptions are that the weight of the bridge is transmitted to the cables by an infinite number of slings, and that the weight of the cables themselves can be neglected in comparison with the weight to be carried by them ; in other words, as expressed in *Military Engineering*, Part III., para. 189, "that the load is uniformly distributed along a horizontal line."

It is obvious of course that the foregoing assumptions are not correct, but the inaccuracies involved are negligible in a field structure and the calculations are enormously simplified.

These assumptions will be adhered to in the following investigation. It is true that the errors introduced may appear to be larger in proportion than in the simple case, but even assuming them to become appreciable, their effect will only be to give the roadway a little greater camber than in the theoretical design, and they cannot therefore be regarded as harmful.

Imagine the solution of the problem to have been effected. *Fig.* 1 will then be a diagrammatic elevation of the bridge. A and B are the

Digitized by Google

anchorages on either side, or may represent the tops of piers over which the cables are strained. CD is the gap to be bridged. In accordance with the assumptions made above, the portion EF of the cable (E and F being vertically above C and D respectively) will be uniformly loaded horizontally, and will in consequence hang in a parabola whose axis OP is vertical. The unloaded portions of the cables AE and FB will be straight and will be tangential to the parabola at E and F. MN is the tangent at the vertex of the parabola, and is of course horizontal.

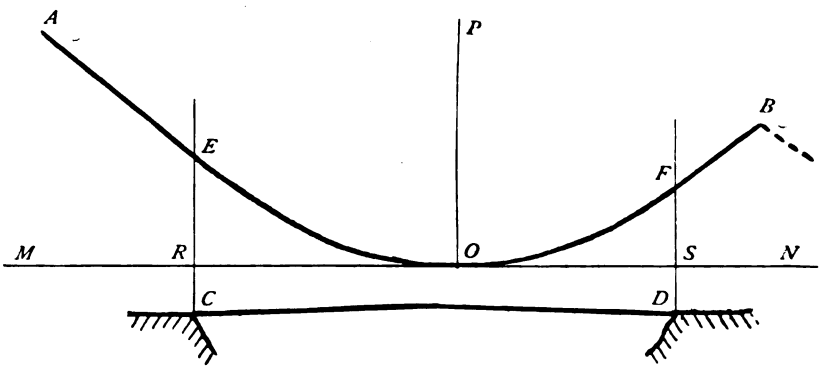



FIG. 1.

The problem to be solved is to find the heights of the points E and F and the position of the axis OP. Another point that might appear to require determination is the position of the tangent at the vertex. As however for any given span the maximum tension in the cables increases as the dip decreases, it is desirable to keep this tangent as low as possible, and its position for any case will be determined by the camber required in the roadway of the bridge, plus an amount required for the length of the shortest sling, due allowance being made for any difference in the level of the abutments.

*Fig.* 2 represents the parabola formed by the cable. The tangents AE and BF intersect in X, which by a well-known property of the parabola is half-way between the lines ER and FS, parallel to the axis, that is to say, Y, vertically above X, bisects RS, the portion of the tangent at the vertex vertically above the gap CD. Moreover the points T and V, in which the tangents at E and F intersect the tangent at the vertex, bisect RO and OS respectively. That is to say, TV, the portion of the tangent at the vertex intercepted between the lines AX and BX, is half RS.

Now the locus of a point that moves so that lines drawn to it from two fixed points intercept a constant length on a fixed straight line, is a hyperbola. However in most cases of the present problem the portion of the hyperbola involved does not differ materially from a straight line, and can be so considered in a graphic solution. If the

Digitized by Google

error thus introduced is appreciable, it can be practically eliminated by a second adjustment.

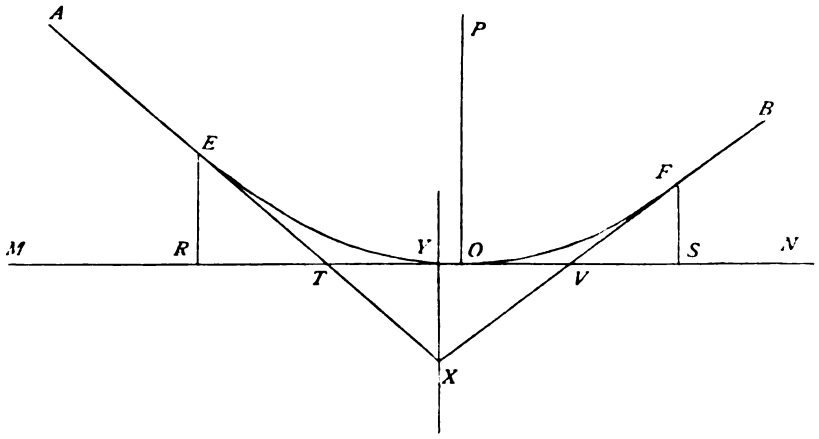



FIG. 2.

The construction then in any case will be as in *Fig.* 3. CD represents the gap, and A and B the position of the anchorages or tops of piers. Draw MN to represent the tangent at the vertex, its position being determined by the considerations mentioned above. Draw CR and DS vertically to meet MN and bisect RS in Y. Let lines AR and BY intersect in G, and let AY and BS intersect in H. Join GH, cutting a vertical line through Y in X. Join AX, BX, cutting MN in T and V. Measure TO along MN equal to RT, then O will be the vertex of the parabola. The accuracy of the construction can be checked by measuring OV, which should equal VS.

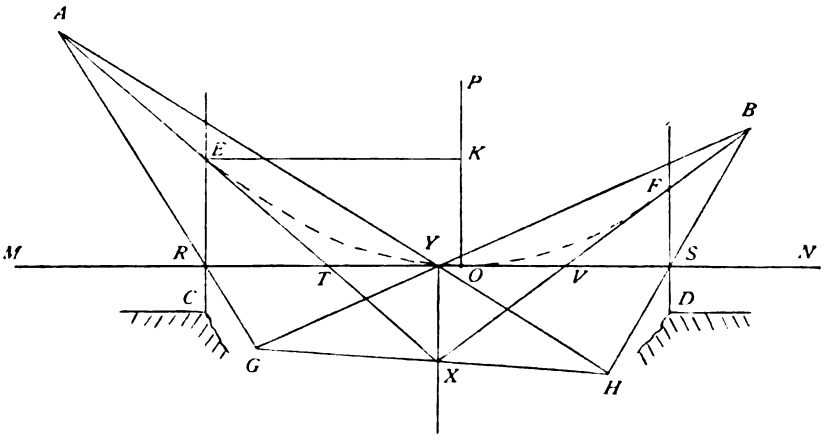



FIG. 3.

Digitized by Google

Should it be found that this is not true, the position of X can be adjusted, as in *Fig.* 4, by taking two pairs of points, $tv$ and $t'v'$, near T and V, and such that $tv = t'v' = \frac{1}{2}$ RS, and by finding the intersections $gh$ of the lines A$t$, B$v$, and A$t'$, B$v'$ respectively. The adjusted position of X will be where $gh$ cuts the vertical line through Y.

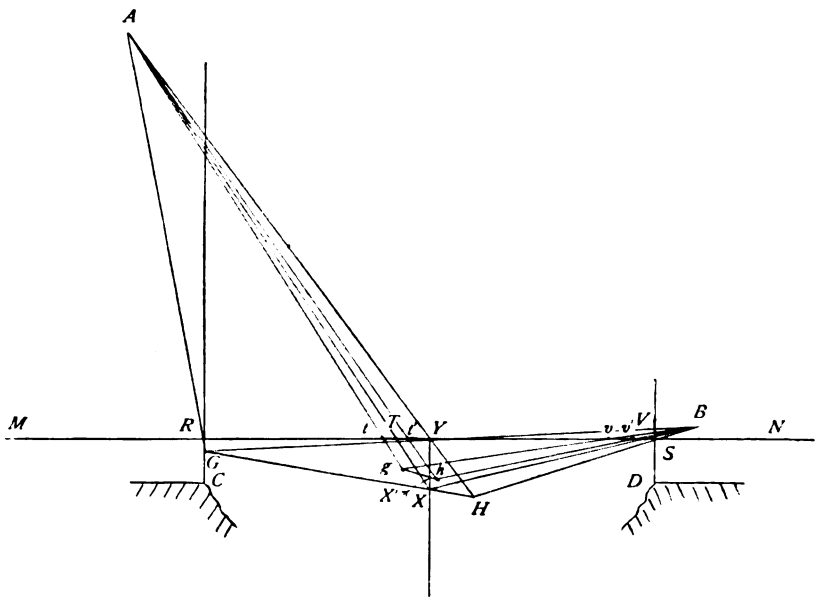



FIG. 4.

When the position of X has been finally settled, points E and F in AX and BX, vertically above C and D, will be the tangent points, and the parabola through EOF can now be completed.

If the tangent at the vertex is on the same level as B, X will coincide with Y, and O with S, and consequently these points can be immediately found.

To find the "dip" of the parabola a horizontal line EK can be drawn, cutting the axis OP in K. Then twice EK will be the equivalent span and KO will be the dip. The horizontal tension can now be calculated, and also the maximum tension which will occur at E or F, whichever is the higher. The length of the slings can also be calculated by the usual formula, or can be measured directly from the diagram. It may be noted that the points E and F are equivalent, as far as these calculations are concerned, to the tops of piers of corresponding heights, and the textbook formulæ can be immediately applied.

Digitized by Google

# *UNSTABLE TERRITORIALS OF IMPERIAL ROME, CIRCA 200 B.C.—100 A.D.*

*By* COLONEL O. E. RUCK, LATE R.E.

IN the May number of the *R.E. Journal* particulars in easily digestible, almost tabloid, form were quoted as to the gradual decadence attending the Roman Territorial movement, circa B.C. 200—A.D. 100. How the enthusiasm evinced in B.C. 224, when Italy alone raised 700,000 infantry and 50,000 cavalry, diminished in an inverse ratio as the years rolled on; and how, owing to various causes, compulsion and corporal punishment had a little reluctantly to be applied, and were even more than a little reluctantly accepted.

Further research enables us to probe more deeply into the true causes of this instability, and to diagnose the complaint by means of its carefully recorded symptoms.

Many changes in the social conditions of the times—such as the admission of conquered provinces to the rights formerly enjoyed by Roman citizens only, the cultivation of the land by slaves, the expansion of Empire on the aggressive-possessive system, which necessitated larger numbers and redistribution of troops, the arising of a mercenary spirit, the carping at and questioning of the nostrums and doctrines laid down by leading men, the extensive employment of foreigners in the Army—had necessarily altered the conditions during the period alluded to.

In lieu of the double free issue of corn,[1] formerly and willingly accepted by soldiers for acts of personal bravery, golden crowns were now expected, golden chains or torques, "corniculæ," or brightly polished horns for helmets, fancy clasps, buckles and golden bracelets;[2] neither were double pay (*duplex stipendium*) nor free extra garments looked at askance.[3]

It was also during this time that military decorations and ornamental trappings (*Phaleræ*) came into use as articles of wear by the Imperial Army Horse (*Equites*), such accessories being provided by and charged to a long-enduring public.[4] Moreover, the rigorous discipline and training exacted, at the very time when an inferior substratum of the population had to be tapped, owing to an increased number

[1] Livy, VI., 110, II., 59. [2] Tacit., Annal. II., 9, III., 53; Juvenal, XVI., 60; Livy, X., 44. [3] Cæsar, Bell. III., 53. [4] Virgil, Aen., V., 310; Livy, XXII., 22.

Digitized by Google

of troops being required for an extended Empire, militated against the popularity of partially voluntary service.

Amongst some of the pains and penalties for wrong-doing were the following minor punishments :—Deprivation of pay[1] (*stipendio privari*) ; to be placed on No. 2 diet of barley instead of on No. 1 scale of wheat (*bordeo pasci*) ;[2] to be bled, or letting out of blood (*sanguinem mittendi*) ;[3] to be expelled into the wilds from camp winter quarters (*a castris segregari*), and to be employed on heavy fatigue work.[4]

Some of the more severe punishments were :—

To be beaten with rods (*Vergis coedi*) ;[5] to be scourged and sold as a slave and to suffer the bastinado (*Fustuarium*), which was the usual punishment for theft, perjury, or desertion ;[6 7] to be overwhelmed with stones (*lapidibus cooperiri*), or by hurdles (*sub crato necari*) ;[8] to be beheaded[9] (*securi percuti*) ; to be crucified[10] and to be left unburied ;[11] to be stabbed by the swords of the brother soldiery ;[12] and, finally, in the days of Imperial Rome, to be exposed to wild beasts or to be burnt alive, etc., etc.

Although the pay of the soldier had steadily, if not rapidly, increased from the sum of 2½d. (B.C. 216) up to A.D. 100, when it stood at 7½d., discipline does not appear to have benefited thereby, for it is recorded in *Tacitus*, Annal. I., 17, that on occasions the extra emoluments received by the men were used in bribing their Centurions, with a view to obtaining certain restrictions from digging, forage, water, and wood fatigues on arriving late in camp after a heavy day's march.[13]

Another source of discontent was due to a difficulty in having to wait before obtaining the "Missio Honesta," or ordinary discharge after 20 years' service with the eagles. To obviate this trouble, Augustus introduced a new kind of discharge termed the "Exauctoratio,"[14] by which all those male adults, who had served throughout 16 campaigns, were exempted from all military duties except that of fighting, their services being retained in a special reserve as "Veterani," until they should receive the full discharge and the rewards for their services (*Præmia vel commoda militiæ*) either in lands or in money, or in both. Sometimes however this final settling up of accounts, as is most carefully recorded, was never completely accomplished.[15]

[1] Livy, XL., 41. [2] Livy, XXVII., 13. [3] A. Gellius, X., 8. [4] Vegetius, III., 4. [5] Val. Max., II., 7, 4 ; Juvenal, VIII., 247. [6] Livy, Epit. 55. [7] Livy, V., 6 ; Cic. Phil., III., 6 ; Polyb., VI. [8] Livy, IV., 50. [9] Livy, Epit. XV., XXVIII., 29. [10] Livy, XXX., 43. [11] Val. Max., II., 7, 15. [12] Tacit., Annal. I., 44. [13] Tacit., Hist. I., 70. [14] Pliny, Ep. VI., 31. [15] Suet., Aug., Cal., Cic., Phil., Virg., Horat., Sat., Tacit., Annal. I., 17 ; Tiber, 48 ; Dio., LIV., 25, etc.

Digitized by Google

# *PROGRESS IN THE MANUFACTURE, TESTING, AND EMPLOYMENT OF PORTLAND CEMENT.*

*By* J. G. BAXTER, F.C.S.

Lecture delivered at Chatham, February 18th, 1909.

I WILL not trouble you with ancient history further than to say that Portland Cement was the name given to a material manufactured from a mixture of chalk and clay as long ago as 1824, the patentee of the material being Joseph Aspdin. The name Portland Cement, I think, arose from the resemblance of this material when set to the well-known Portland building stone. Of course, at this early stage and for many years afterwards, the manufacture of Portland Cement was conducted on an extremely small scale, and in a very haphazard fashion; indeed, a great quantity of this material was never even calcined to incipient vitrification, as is necessary for the production of what is now called Portland Cement. From a variety of causes, for a long time very little notice was taken of this new material, but its obvious advantages gradually brought recognition, and we find that about 1850 it was being manufactured in Kent, at Northfleet, by Messrs. J. B. White & Sons, from chalk on their own premises and clay from the saltings at the mouth of the Medway, and also at one or two other very small factories. The majority of the records previous to this date are those of Major-General Pasley, who appears to have devoted considerable time and attention to the whole matter.

After 1850 however the manufacture of Portland Cement began to go ahead, possibly due to some extent to the interest the material excited during the Great Exhibition of 1851, and also began to get on more or less general lines. Several factories in and about Northfleet, on the Thames, and Rochester, on the Medway, came into being. This was of course only natural on account of the proximity of practically inexhaustible supplies of what is perhaps the best, and certainly the most easily worked, raw material for the manufacture, namely, chalk and Medway clay.

The general method of manufacture about this time was as follows:—The chalk was dug then, as now, from the cliffs near the works and the clay brought from the Medway saltings in barges. These two materials were put down somewhere near an arrangement called a washmill, consisting of a kind of pan about 12′ or 14′ in diameter and about 4′ deep, in which revolved harrows with tines on much the same principle as those one sees in the fields. The materials were shot

Digitized by Google

into the washmill in the proportions of practically 3 parts of chalk to 1 part of clay, together with a very considerable amount of water, some 70 per cent. in fact, and produced 2 parts of cement. The action of the mill naturally broke up the chalk very fine and mixed it with the clay and water into what was called "slurry." This "slurry" was pumped into large tanks called "backs," some 4′ deep and about 1,000 square feet in area, in which it was allowed to settle. When, after a long period, by drainage and evaporation the mixture had become fairly stiff, it was dug out and wheeled away to "floors." The "floors" consisted of iron plates, covering flues, along which the products of combustion from numerous furnaces travelled, on which it was heated until dry. The dry material, called "slip," was then taken and placed in a kiln much the same as a lime kiln, in layers of some 8″ or 9″ thick, each layer of slip having between it a layer of coke some 3″ or so thick. The material was lighted at the bottom of the kiln, and in the course of four or five days, according to the size of the kiln, had burned out, and there remained some 20 tons or so of a semi-fuzed mass called "clinker." This was then wheeled away to crushing machines. (In very early days the clinker was broken by hand, but this was soon given up owing to the cost). After passing through the crushing machines it was put through millstones about 4′ 6″ diameter made of French burr, a peculiarly hard and tough stone. The product of this grinding was the Portland Cement of commerce.

This describes in brief the method of manufacture about 1850 and for some very long time afterwards, indeed, even to-day in one or two of the very old factories this same method is in use with some slight modifications. The first improvement of any real moment was the transition from what is called the "wet" process to the "semi-wet," that is to say, instead of breaking up the chalk and clay with about 70 per cent. of water, this was done with 40 to 45 per cent., and the product of the washmill was in this case passed through millstones to obtain the particles of chalk in a finer state than had previously been the case. The raw product was now in the state of a thick kind of mud, and this, instead of being pumped to the backs or ponds, was pumped direct to the drying floors. This stage marks a real advance, both from the point of view of cost and of quality, as it showed a recognition of the advantages of the finer grinding and better intermingling of the particles of the two ingredients in producing a better quality of clinker. About the time this semi-wet process was introduced a few of the better class manufacturers began to recognize the influence of a more regular proportion of chalk and clay in the slurry upon the regularity of their cement, and an instrument called the calcimeter was introduced. This instrument was used for testing the proportion of chalk in the slurry, and thus indirectly the amount of lime in the finished cement. Previously the regulation of the proportions of chalk and clay had

Digitized by Google

been done in a very rule-of-thumb way. Some manufacturers burned a small portion of the mixture in a sample kiln, which was a practical way, but others judged the composition by tasting the slurry or by looking for crystals of lime as they were called in the clinker, others again in other ways equally ridiculous.

The next advance was of more use in reducing the cost of manufacture than in improving the quality of the product. It was the addition of a drying chamber to the bottle kilns, whereby the waste heat from the burning of one charge dried the slip for the next charge; this method is still in use to some extent.

About 1880 a Mr. Ransome conceived the idea of calcining the raw mixture in a rotary cylinder and thus doing away with the large amount of labour employed in the loading of the intermittent kiln, as it is called. This process was tried at two or three works in England, at Arlesey, near Cambridge, and at Gibbs' Works, at Grays, Essex. Producer gas was used for firing and the kiln was about 30′ long by about 3′ diameter. The process however proved a failure owing to several causes, the principal one being the difficulty of generating sufficient heat to calcine the raw materials. During all this time, as may be imagined, the demand for cement had been increasing enormously, and this district had become the centre of the industry, cement being shipped to all parts of the world from here. This state of things, of course, could not continue indefinitely, and people in other countries and other parts of our own country began to cast around for raw materials, and naturally found them, although not in the same form as chalk and clay. For a long time it had been thought that these two materials were absolutely necessary for the production of cement, but with better knowledge of the constituents it became obvious that any materials or combination of materials having the right composition, without any deleterious admixture, could be used successfully.

During the whole of this time Portland Cement had been essentially a British production, and all advances and improvements had been made in this country. The next real advance however was made in America. It was found there that although there was no chalk available there was an abundant supply of limestone, and shale instead of clay. These materials however on account of their characteristics did not lend themselves to the same treatment as in England. They could not be ground sufficiently fine unless they were dried, and as they contained only a comparatively small amount of moisture, this was easily done. Now after they had been ground together, it was on the face of it foolish to add a lot of water which would have to be evaporated to the material, merely to get it into a condition to load into intermittent kilns, which themselves would have meant a lot of expensive labour; so here was the opportunity for the rotary kiln. The Americans however did not bother with gas

Digitized by Google

firing; they started with oil and with kilns 60′ long, and after some little time were successful with this method of manufacture. Oil firing however was somewhat expensive, and ground coal was tried with success.

The Germans had during this time been faced with somewhat the same difficulty as the Americans, but as labour with them was cheap and fuel comparatively dear, they struck out a new line by the introduction of the continuous chimney kiln, in which the least possible amount of fuel is used. The dry materials, after being ground together, were pressed into bricks and burned in a very tall, narrow kiln, with alternate layers of fuel and slip or bricks, being continually loaded at the top and drawn at the bottom. This system, although much cheaper in fuel consumption than the rotary kiln system, was somewhat costly in labour. During this time, both in England, America, and on the Continent, it had been recognized that the more finely ground the clinker the better the resultant cement, and it soon became apparent that something better than millstones were required for this purpose. Very many different mills were invented and tried, but the most successful machine, and the one which made the great advance in grinding possible, was the tube mill. This consists of a cylinder 30′ × 5′, supported at both ends and revolving at about 27 r.p.m., lined with steel plates and about half-full of pebbles (*Fig.* 1). Practically every manufacturer got one of these mills and put it on to the end of the mills he was then using, in the great number of cases millstones. After this came the ball mill, which is now almost universal in place of millstones as a preliminary grinder for a tube mill.

This consists of a drum 6′ × 5′ long, revolving about 25 r.p.m., with steps inside, and having inside a charge of about 2 tons of steel balls from 5″ diameter downwards (*Fig.* 2). These, by their action of rubbing against one another and falling over the steps, break up the clinker fairly fine, and from here it passes to a tube mill to be finished.

It will be obvious that, by the infinitely increased fineness of grinding, the chemical action of the water when added to the cement was enormously increased, and quick-setting cements resulted, and, owing to the better results obtained from a comparatively slow-setting cement, some method of regulating the setting time became necessary. Many things were tried, but until a few years ago the only one which was of any practical use was the addition of from ·5 per cent. to 2·5 per cent. of gypsum. Since then however Mr. Bamber has invented what is called the hydration process for this purpose. This consists of blowing a certain amount of steam, depending on the setting time required, into the tube mill (*Fig.* 3).

This process has much simplified the setting time question, as well as improved the quality of the cement, owing to the effect of the steam in making stable the less stable compounds in the cement.

We will now turn to the question of burning clinker in England

Digitized by Google

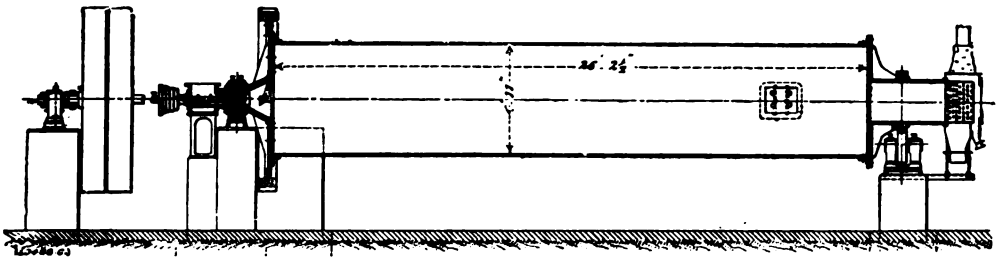


FIG. 1.—Longitudinal Section of Tube Mill.

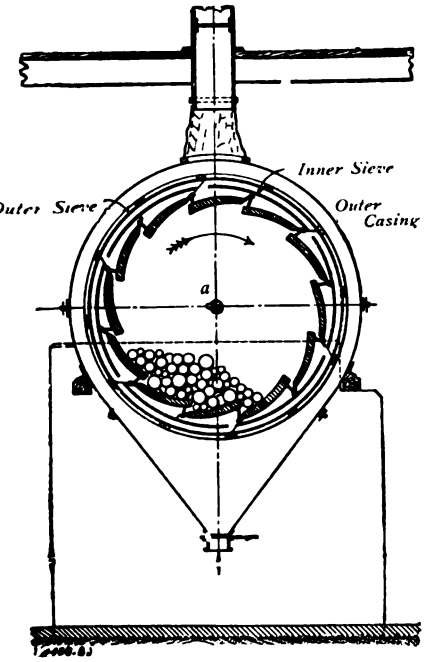



FIG. 2.—Section of Ball Mill.

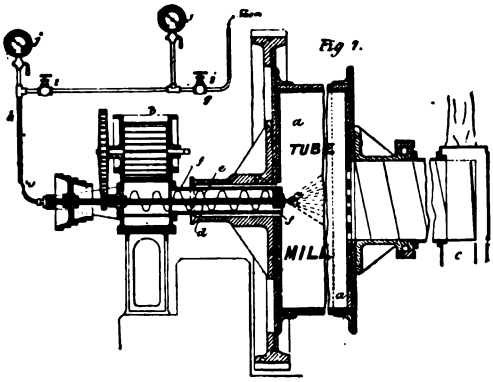



FIG. 3.—Hydration Apparatus applied to Tube Mill.

(British Patent No. 22735/02).

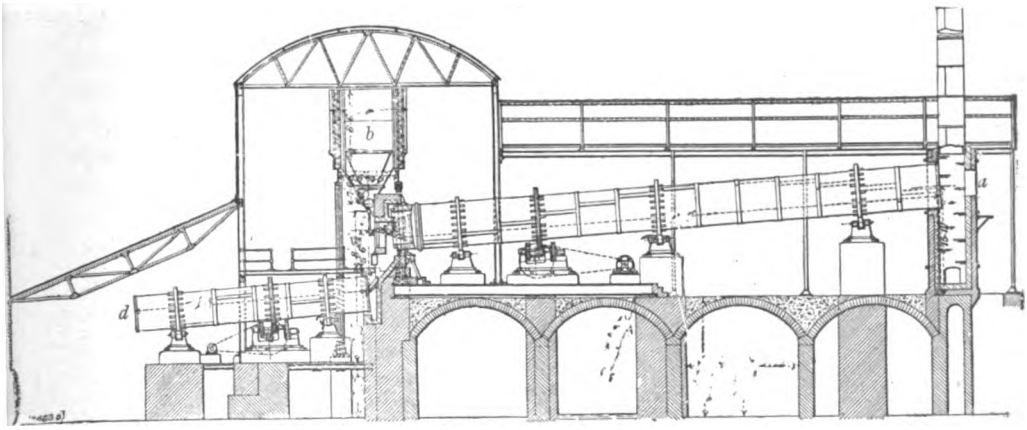



FIG. 4.—Section of Rotary Kiln Plant.

*a* Slurry Feed End of Kiln. *b* Powdered Coal Hopper. *c* Jet Burner. *d* Cooler.

Digitized by Google

Digitized by Google

again. When it was seen that the rotary kiln with powdered coal was successful in America, the English manufacturer began to recognize that he would benefit by it, and a battery of 16 was erected at the J. B. White works of the Associated Portland Cement Manufacturers about 1900. These were 70′ long by 6′ diameter, but have been improved out of recognition by lengthening and in other details, until, whereas they produced in 1900 about 1,500 tons per week, they are now producing some 7,000 tons. The limit has not however been reached, as there are now being erected kilns 160′ long by 10′ diameter.

I will now give a description of a modern cement works.

In the wet process, with soft wet raw materials such as chalk and clay, the chalk is dug by steam diggers in some places and by hand in others, the clay being dug by grab dredger. Both of the materials are brought to the washmills in wagons holding a definite amount, the contents of the wagons being shot into washmills of a larger and stronger type than that previously described. The washmills are in batteries of about six, the materials and water passing on from one mill to the other through a screen, each mill having on a finer screen than the previous one, until, after passing the sixth mill, the whole of the slurry has passed through perforated plates with holes only $\frac{1}{40}$″ diameter, and is practically an impalpable powder mixed with water.

The proportions of chalk and clay are regulated by a chemist, who takes a sample from the washmills every half-hour and tests the proportions of the ingredients by means of a calcimeter, and also the percentage of water present, which should be about 40 per cent.

The product of these mills is so fine that only some 3 per cent. of the material is too coarse to pass through a 32,400-mesh sieve.

The slurry, as it is called, is then pumped to large storage cisterns about 70′ diameter by 10′ deep, each holding sufficient for 500 tons of cement. In them the slurry is kept in constant agitation night and day. Just before a cistern is full the chemist takes a sample and tests it. If the composition is not exactly right, it is made so by the addition of slurry rich in chalk or in clay, as the case may require. After thorough mixing in the cistern, the slurry is pumped away to the rotary kilns.

In the dry process, with hard, comparatively dry materials, such as limestone and shale, after crushing, each is shot into its own dryer, consisting of a revolving cylinder about 5′ diameter by about 50′ long, with a furnace at one end; this drum being inclined, the material passes along through it, meeting a current of hot air from the furnace and losing the whole of its moisture. The two materials are then elevated into hoppers, each with an automatic weighing machine set to deliver a certain amount of each material, according to the proportion determined by the chemist in charge, who is constantly taking samples for testing and altering proportions when necessary. After being weighed the materials come together and go into a mill, in the

Digitized by Google

majority of cases a ball and tube mill combination, where they are ground to an extreme fineness and then elevated to large storage hoppers, from which the mixture is fed to the rotary kilns.

From this stage onwards the dry and wet processes are alike, and are as follows :—

The rotary kiln is a long cylinder about 150′ × 7′, inclined to the horizontal about $\frac{1}{2}''$ to the foot. This cylinder is mounted on several sets of roller bearings at suitable intervals, and is rotated through gearing by a motor, the speed of which can be varied. This cylinder revolves about 1 r.p.m., and is lined about three-quarters of the way along from the lower end by fire-resisting blocks ; the remainder of its length is sometimes not lined, sometimes lined with concrete. The upper end projects into a housing connected with a large flue with dust-catcher arrangements, this flue ending in a large chimney some 250′ to 300′ high (*Fig.* 4).

The raw materials enter the upper end of the kiln and soon lose whatever moisture they may contain by meeting the heat travelling up the kiln. The next stage, as they get nearer the intense heat, is the loss by the chalk, or limestone, of its carbon dioxide. This occurs when the temperature is some 700° C. The material is now in the form of small balls about the size of a walnut, and next coming into the hottest part of the flame, about 1,400° C., these are cintered, and combination takes place between the lime as it now is and the clay, forming, when cold, a dense hard black nodule. The whole of this operation is under the control of a skilled attendant, who watches everything through smoked glasses and has control by levers just to his hand of the coal supply, and consequently the heat, the speed of rotation of the kiln, and the speed of supply of raw material. It is here where the great difference will be noticed between the new and the old process. In the old, when a kiln was loaded it was left to itself, and good, bad, or indifferent product was to a great extent a matter of luck. Here it is a definite and controllable operation. The white-hot clinker then falls into a cooler, which is a cylinder inclined like the kiln, about 50′ long by 6′ diameter, fitted with shelves, which, as the cooler rotates, picks up the clinker and drops it through the current of cold air rushing up through it to supply the necessary oxygen for the combustion of the coal in the kiln.

The clinker now issues quite cold and is taken to hoppers over the grinding mills, which are almost invariably of the ball and tube variety already described. In the tube mill the nearly finished cement is subjected, as has already been described, to a steam-saturated atmosphere, the degree of saturation of which can be controlled. From this mill it goes straight to the warehouses, where it lies in heaps until tested by the customer and despatched.

It will now be seen how from a very rough-and-ready hope-it-will-be-all-right way the manufacture of cement is now in all the stages

Digitized by Google

under the most perfect control, with the resultant most satisfactory product.

Some work has been done in America by actually fuzing the raw material to clinker in a kind of blast furnace to save the preliminary grinding and mixing, but has come to nothing.

We will now compare the cement of 50 years ago with that of to-day, and you will see the enormous advance that has taken place in the quality.

*Setting Time.*

| | |
|---|---|
| Was whatever it happened to be. | It is now almost anything one asks for. |

*Fineness.*

| | |
|---|---|
| Was 20 per cent. residue on 2,500-mesh sieve. | It now is commonly 5 per cent. on 32,400, and sometimes as low as 2 per cent., although only 18 per cent. is guaranteed. |

*Tensile Strength.*

| | |
|---|---|
| Was about 400 lbs. on a $1\frac{1}{2} \times 1\frac{1}{2}$ brick at 7 days, that is 177 lbs. per square inch. | It now requires 600 to 700 lbs. on $1'' \times 1''$ briquettes at 7 days to break it. |

*Soundness.*

No comparison whatever, as no tests were made until comparatively recent years.

We now come to the question of testing, which is, as you know, very important, and the source of almost all the dissatisfaction between manufacturer and user.

From the very first some attempt has been made to test the strength of the cement supplied, and naturally these attempts took the form of tensile tests as being the most easily carried out. The early experimenters in this direction chose the very practical way of sticking two bricks together with the cement and seeing how much pulling apart they required. Various forms of this test were in vogue until the briquette mould was introduced. The cement after gauging was put in this mould, allowed to set for a certain period, sometimes under water and sometimes not, and at given dates the briquette was put into a machine and weight applied until the briquette broke. The early briquettes had a breaking section of $1\frac{1}{2}'' \times 1\frac{1}{2}''$. This size was customary for some time, but the unwieldy nature of the briquette, together with the fact that the quality of the cement was constantly improving, necessitated the making of a smaller briquette, and the $1''$ section was adopted, which to-day is the standard in English-speaking countries. The shape of the mould has undergone certain modifications, but through the efforts of the British Engineering Standards Committee one particular shape has

Digitized by Google

now been agreed upon, at least so far as this country is concerned. The shape adopted by other nations differs but little from our own. About the time of the advent of finer grinding it was noticed that the tensile strength of the neat briquettes did not show the increase in strength which it was thought finer grinding would give; and as cement was seldom used without an aggregate, sand briquettes began to be made. At first of course this was done in a very rough way, but later, as the value of this test was recognized, a standard sand was adopted and also a standard proportion; the standard sand comes from Leighton Buzzard and must all pass through a 20-mesh sieve and all be retained on a 30-mesh; and the standard proportion is 3 of sand to 1 of cement, by weight.

The first tests for soundness were made many years ago by simply making up a block of cement and noticing whether after a certain time it fell to pieces or not. Then small pats were made up, sometimes on glass, and after having set were immersed in water. After different periods they were examined to see if they had cracked.

The first real attempt to get a satisfactory soundness test quickly was made by the late Mr. Henry Faija, who instituted the test which bears his name; this was the placing of a pat of cement, gauged with about 25 per cent. of water, in moist air for four or five hours, and then in water at 115° F. for 17 or 18 hours. If the pat did not then show any cracks, the cement was considered sound and fit for use.

The advances on this particular test came as follows:—First the Deval pat, which was similar but the temperature was increased to 170° F. After this came the boiling test; in this case the pat, after being allowed to set in air for 24 hours, was subjected to immersion in water, which was then brought to boiling point and maintained there for six hours. M. Deval, in addition to the pat test as described, instituted another on somewhat similar lines, namely the Deval briquette test. This test consists of making up briquettes of 1″ section both neat and with sand, allowing them to remain in air 24 hours, and then placing them in water at 170° F. for six days, after which time if the cement is sound it is supposed to show a strength equal to that to which a similar briquette treated in the usual way would attain in 28 days. This is a fairly good test, as if there is anything radically wrong with the cement no strength will be obtained.

Several other tests of more or less value have been invented, but have now dropped out of use, such as making a ball to just pass through a certain ring, boiling it, and then seeing if it still passed this same ring; also making up pats and subjecting them to a high temperature in an oven and noting their behaviour. A very elaborate machine was also devised in Germany for measuring the expansion of small bars of cement; numerous other tests of less note have been also devised.

The accelerated test however, which has been adopted by the

Digitized by Google

British Standard Specification Committee, is that known as the Le Chatelier expansion test, a test which has the merit of being simple and one whereby the degree of merit, so to speak, of the cement can be measured, and withal it is fairly severe. This test consists of gauging up the sample of cement (after it has been laid out in a thin layer some $\frac{1}{4}''$ thick for 24 hours) with about 23 per cent. of water and placing it in a split cylinder, packing it fairly tightly to remove air bubbles. Over each end is placed a small piece of glass or metal, and the mould is then placed under water. After 24 hours it is taken out and placed in boiling water for six hours, preferably being placed in cold water and brought up to the boil. The distance between the ends of the forks attached to the cylinder is measured just before boiling and again after boiling, the difference between the two readings representing the expansion of the cement under test. This, according to the standard specification, must not exceed 10 millimètres after 24 hours aeration. But if it does the cement need not be condemned, but is left spread out for a further period of six days, with occasional turning over, and again tested as before; if this time it does not exceed 5 millimètres, it may be assumed to be quite satisfactory. Something even more stringent than this is called for at times; thus considerable amounts of cement are supplied to a specification which only allows 1 millimètre expansion after 24 hours' aeration, and such are modern methods of manufacture that it is quite possible to do this, although at a somewhat increased cost. Should anyone be in a hurry to get this test over and not want to wait the whole six hours for the result, I may say that an expansion of under 10 seldom goes any further after one hour's boiling.

The analysis of cement is a somewhat long process, and although to some extent necessary, it has only come into vogue in the last few years, although a few of the more advanced users of cement have been in the habit of specifying a certain limit to the amount of calcium oxide a cement should contain, for some considerable time. Then it was recognized that some limit should be placed on those manufacturers who did not scruple to add cheaper inert material to their product, obviously for their own benefit. Thus the insoluble residue is limited to $1\frac{1}{2}$ per cent., which prevents such things as broken bricks, silica, etc., being ground with the clinker. The percentage of magnesia also received attention, chiefly owing to a very considerable failure of work in the Aberdeen Harbour. A limit has been put to this, namely 3 per cent. Sulphuric anhydride is also another ingredient which it is as well to keep within reasonable limits, this being set at 2·75 per cent. Sulphides should be excluded, although with the modern cement manufactured from the usual materials it is not likely that much of these compounds will be present, as they disappear during calcination, especially in the rotary kiln. The proportion of calcium oxide to that of alumina and silica

Digitized by Google

should also be within certain limits represented by $\frac{CaO}{SiO_2 \& Al_2O_3}$, calculated in chemical equivalents, not being greater than 2·85. Thus slag cements, or additions of slag cements, or the dangerous Belgian natural cements are detected.

The chemical analysis however should never be carried out except by one very experienced in this class of work ; any amateur attempt is sure to lead to trouble.

Now as to the weight of cement. A heavy cement has from the very earliest times been looked upon as a proof of a good cement, and thus among the first tests was the old one of weight per bushel ; the heavier a bushel of cement the better was thought to be the quality. In course of time a regulation hopper was designed for filling, as there was scarcely any limit to the weight of cement which would be packed into a bushel measure by shaking and such dodges. As fine grinding came in however it was recognized that whatever use this test might have been formerly, it was no longer of any value, as the more finely ground the cement the lighter it weighed, independently of the kind of clinker it had been made from. This test gave way a few years ago, although then only very gradually, to the more rational and scientific one of specific gravity, which is not affected by the fineness of grinding. The minimum specific gravity has been fixed by the Engineering Standards Committee at 3·15 for freshly ground cement and 3·10 for cement which has been ground four weeks. This test is of use chiefly for the detection of adulterations by natural and slag cements, as well as of limestone and other such material, and is fairly simply carried out. It is however a test in which care should be exercised ; it is very easy to carry out, but equally easy to get a wrong result.

We now take the fineness of the cement. You will recognize that only certain portions of the cement are of any use as cementitious agents, the coarse nibs simply behaving like so much sand, at least for a very considerable period after use. Roughly speaking, the cementitious particles are those which will pass a 200 × 200 mesh to the square inch sieve, that is a sieve containing 40,000 meshes to the square inch. There has been only one way of carrying this test out all along, that is by sieving the product. The start was made with a 50-mesh sieve, that is one with 2,500 holes to the square inch. When this test was first introduced 25 per cent. was the usual residue on this sieve ; as competition grew stronger and the value of fine grinding was recognized, this figure was reduced, usually by one manufacturer going one better than his rival, until about 12 years ago 5 per cent. on this sieve was the practice.

Since the advent of better machinery the 50 sieve has disappeared, and the 180, that is one with 32,400 meshes to the square inch, takes its place, which you will see is a very considerable advance. Well,

Digitized by Google

the start on this 180 sieve was 25 per cent., then three years ago 22½ per cent., two years ago 18 per cent., and to-day many firms, notably the Associated Portland Cement Manufacturers, who are the pioneers of fine grinding in this and all other countries, are supplying quite as an ordinary thing cement leaving only 5 to 6 per cent. of residue on a 180-mesh sieve, or 10 per cent. residue on a 200 sieve (40,000 meshes to the square inch). This is at present, and is likely to remain for some time, the limit. I may say that in testing with these very fine sieves it is not sufficient merely to roll the cement about in the sieve; it must be very vigorously shaken and knocked on a bench or something, or the wires will get clogged and it will be impossible to get the quantity of stuff which should go through to pass. There have been some attempts made at different times to get a machine which would separate the flour from the useless material. The only one however which has had any measure of success is that known as the Goreham Flourometer. This is an apparatus by which a certain amount of air at a certain pressure is blown through the cement and carries with it the finer particles of cement; the residue is weighed, and by difference the amount of flour is obtained. This is a cumbersome machine and is of very doubtful value indeed. Recently an attempt has been made to supply the elutriation method with turpentine instead of water to this purpose, but this again appears to be an attempt to supercede a simple and sufficient test, at least for practical purposes, by something much less reliable.

Setting time. This test is one of considerable importance. In the early days when any test was made of this property a mass of about 14 lbs. was mixed up with whatever amount of water the operator considered necessary and put on a piece of board or stone, or even left on the ground independently of whether it was cold or hot; the gentleman testing then promptly forgot all about it for about six hours, when he came back and usually found it set, which was of course all right. Gradually this gave place to more exact methods, commencing with gauging up a comparatively small amount and making a pat, considering it set when the thumb nail applied more or less lightly to the surface made no impression; here one can recognize almost unlimited possibilities for mistakes. This however gave place to a pat made up with an amount of water usually 22·5 per cent., but even now, left in the British Standard Specification, somewhat ambiguous, and a so-called needle of a particular pattern placed on the pat at suitable intervals. This needle weighs 2½ lbs. and has a point $\frac{1}{16}''$ square. When this needle fails to make an appreciable impression the cement is considered set. Incidentally, the initial set is supposed to have commenced when the needle fails to completely penetrate the pat. Neither of these give an absolutely accurate result. I personally consider the needle used on the Continent known as the Vicat Needle gives more accurate results, but is

Digitized by Google

much more troublesome to work than our standard needle. In the first place, with the Continental, or Vicat, Needle a definite amount of water is used and the thickness of the pat, or in this case block, is prescribed, also the final mark is more easily placed. The easiest way to take the final set with the British needle is to take the mark just before all four sides of the point of the needle are not clearly shown after lightly applying it, and only allowing it to remain just long enough to get the weight of the needle. This final mark has become somewhat more difficult to detect since the advent of cement made in rotary kilns, as such cement, being practically pure, has the peculiar property of setting and still remaining just impressionable on the surface to the British needle for considerable periods after it has really set. Thus, although the setting time of a given cement may be only one hour, it is quite possible to get this peculiar impression up to some four hours afterwards, and this of course may easily give rise to disputes. In addition to this point it should be stated that the setting time of cement is the point over which mistakes in testing are most likely to be made. Care should always be taken to keep the temperature as near 60° F. as possible ; always make sure that the cement is cold ; always put the pat of gauged material on non-porous stuff, glass preferably ; keep the pat away from direct heat from any source, especially sun ; keep out draughts as far as possible ; also gauge up with as near 23 per cent. of water as possible, but in any case the pat must show wet when finished, but not be at all sloppy.

An attempt has been made to record the setting time by recording the rise in temperature by means of an apparatus consisting of a kind of camera, which photographs the height of a column of mercury in a thermometer placed in a block of gauged cement. Needless to say, this is another of those things which are interesting scientifically, but of very little practical value.

Now to return to the tests for tensile strength. I have told you how matters are now practically settled down to the 1″ section briquette of the well-known shape, both for sand and neat briquettes. In addition to the cement having a certain tensile strength at seven days, it has been recognized, more especially of late years, that this strain should show a certain increase as time goes on ; naturally not so great when the starting point is high, but still some. Thus it has been settled that from 7 to 28 days the increase should be from 25 to 5 per cent., varying according to the seven days' result in the case of the neat briquettes, and 20 per cent. in any case for the sand briquettes.

Now a great deal of care is necessary in making up briquettes. It is about as easy a thing as possible to fill a briquette mould with a mixture of cement and water, or cement, sand, and water, but as in the case of many other things there is considerably more in it than appears on the surface. Thus most of the gauging done now is what

Digitized by Google

is called dry gauging. That is to say the neat cement is mixed with only about 18 or 19 per cent. of water and the sand briquettes with about 8 per cent. Whether this method of gauging, or that with about 22½ per cent. of water, is used, it is absolutely necessary that the water and the cement be very thoroughly worked together for some little time before being placed in the mould. Also the mould should not be filled in one lump, but a small piece must be pressed into place with a piece of wood; another portion is then placed in the mould and this lot is pressed into the other, and so on until the mould is full, and in fact more than full, so that a thoroughly sound, close briquette, free from air bubbles, is produced. The whole of this operation, after the addition of the water, must be carried out as expeditiously as possible, preferably gauging only sufficient to fill one mould at a time. The top should be smoothed off and the mould allowed to stand in air 24 hours; preferably the moulds with the briquettes in should then be covered over with a piece of sack (not a cement sack, by the way—they are valuable) saturated with water.

In making a sand briquette the sand and cement should be very thoroughly mixed before water is added, and even more care should be taken in compacting these briquettes than the neat ones; also they should be very carefully handled when being removed from the moulds, as they are easily damaged. When breaking briquettes they should be placed in the clips very carefully and squarely, or a bad break will result. When briquettes which have been boiled or placed in the Deval bath are to be broken, they should be allowed to get cold before breaking, or a much lower strength will be shown.

One further test for cement, I may mention, is now coming to the fore, the compression test. This is really a more useful test than the tensile one, but is far more difficult to carry out, the necessary apparatus being more cumbersome and the results not quite so regular. Although concrete is practically always used in compression, the carrying out of this test is not perhaps so important as it might appear to be, because the more easily obtained tensile strength bears a fairly constant ratio to the compressive strength, namely, 1 to about 9. However when carrying out this test the largest sized blocks should be made that it is possible to deal with in one's machine, a hydraulic machine should if possible be used when crushing, and great care must be taken in placing the blocks fairly in the machine. The pressure really should be applied, especially on smaller sized cubes, through leather or felt or something which will take up the irregularities of the surface; also the cubes should be crushed the way they are made. If carelessly made they may be laminated, in which case if crushed sideways a poor and unrepresentative result will be obtained.

I should like to add that if on testing a cement anything is found to which exception is taken, the point should be very carefully looked

Digitized by Google

into before blaming the manufacturer, and in nine cases out of ten, especially if the cement be the product of a reputable English maker and guaranteed to comply with the requirements of the British Standard Specification (and no cement used, at least by any of our countrymen, should be anything else), it will be found that it is not the cement at all, but some little thing in the testing. Thus one example :—A cement may have been ordered of a slow-setting kind. It is sent out to, say, India and tested on a fearfully hot day by someone who wants to get away from the job. Well, he may make it a medium or even a quick setter, according to the heat or the length of time he has at his disposal, and the manufacturer is blamed. It is not much use, for example, if you have an hour to spare to start to make a setting time test of a slow-setting cement; something is going to be wrong. I could give you dozens of examples such as these which have come to my notice, where the manufacturer is blamed quite without cause.

Now, as to the progress in the use of Portland Cement. From the very earliest days of the industry the use of this material was simply as a substitute for the lime, hydraulic and other, and for the various Roman cements in use prior to its introduction. During the first half of last century Portland Cement had a very hard fight to demonstrate its superiority over the articles just mentioned, some of which had been in use since the earliest times ; indeed it was not until the latter half of the 19th century that Portland Cement by its constantly improving quality and inherent advantages really began to seriously displace these materials. During this period however we find an ever-increasing quantity of large works carried out in Portland Cement concrete, until to-day there is comparatively little demand for lime or the other kinds of cement, except perhaps natural cements, which mostly come from Belgium, and even for these the demand is very properly dying.

In the early days of its use, and even later when it was becoming more widely known, there were several failures of works carried out with this material, and this naturally had the effect of to some extent retarding its progress. These failures were practically all due to the fearfully bad quality of the product, owing mainly to the very crude methods of manufacture then in use. The really intelligent use of Portland Cement may be said to have begun about the time the system of construction known as reinforced concrete was invented. This is commonly attributed to M. Monier about 1876. It must not be thought that the use of iron in concrete was not known before this, as I have seen concrete made many years before that date which had bars, old rails, and so on embedded in it. The iron which was put in however was placed, one might say, indiscriminately; no reliance was placed on it, the sole idea being that while it did no harm, it might make the concrete stronger. About this time how-

Digitized by Google

ever the price of cement had become much lower, and larger works were being carried out in concrete, more attention was being given to the subject in this country, in Europe, and in America, and the larger users began to recognize that concrete was something more than an indiscriminate mixture of stones, cement, and water. It was found, for instance, where any notice was taken of the strength, that less cement need be used to obtain a certain strength than had previously been the case. Also the different kinds of aggregate used began to be studied as to their nature, etc., the results of mixing certain sands in certain proportions, and so on, and an immense amount of very profitable experimental work was done in this direction, the more so as reinforced concrete with its definite formulæ came more and more to the front. The history of the more intelligent use of Portland Cement is simply a record of steady progress, to which an extra fillip was given by the introduction of reinforced concrete. Although throughout all the latter half of the 19th century there were daring spirits who attempted to use concrete for many different purposes such as house building, etc., these attempts, from an economical point of view, were mostly, I might almost say invariably, failures. It was not until the present century that a thorough knowledge of the material showed its marvellous adaptability, now so well known and so highly appreciated. Where one building was being erected in concrete in 1900 we find now dozens, where it was being used for one purpose then we now have scores, and practically the whole of them economically successful. It is impossible to enumerate the whole of the various uses to which concrete plain and reinforced is being put, but some of the most interesting are fence-posts, railway sleepers, linings for colliery shafts, props for coalpits, stopping holes in ships, building barges, electric-light standards, telegraph poles, and innumerable other purposes. The last one which has come to my notice was a suggestion made by Mr. Guttman, the expert on explosives, to construct magazines of reinforced concrete, with the idea that should an explosion occur there would be infinitely less possibility of the results of the explosion of one magazine being communicated to the contents of another, as owing to the embedded steel work there would not be such a tendency for masses of constructional matter to fly about. Indeed, he stated that in the event of a bad explosion the concrete would practically go to powder or at any rate very small particles. I am not prepared to say whether this would be the case or not, as I am not an expert on explosives; but the fact remains that magazines are being put up in Germany in reinforced concrete. Now as to the present-day use of Portland Cement in the manufacture of concrete for various purposes. I can best put this by saying what should be done and what should not be done. In the first place, and most important, see that you get pure Portland Cement complying in all respects with the requirements of

Digitized by Google

the British Standard Specification. All natural and slag cements should be absolutely barred; there is not sufficient difference in the price to warrant the risk. In the next place, get cement with a right setting time, and the slower the setting time in reason you can manage with, the better results you will get. In this connection I may say that the difference in strength of concrete made with quick and slow-setting cement is inappreciable after less than 48 hours. Choose the cleanest possible aggregate and sand, and don't use anything which cannot be described as clean without making considerable experiments before doing so. Also be careful as to the water you use for mixing the concrete. Special care must be taken with the aggregate when intended for reinforced work, in order that nothing injurious to the steel be included. Proportion the cement, aggregate, and water carefully and see that the proportion is strictly adhered to. Also mix the cement and aggregate well before adding the water. If the work in hand warrants its use, have a concrete-mixing machine and see that it is used intelligently. Also be absolutely certain that any reinforcement is in the position it is intended to occupy.

Now as to some of the things which should not be done. Don't aerate the cement; present-day cement does not require this. Satisfy yourself that it is to British Standard Specification; if it is, use it as soon as you can; if it is not, don't have it. Don't store it in a damp place and expect it to keep indefinitely—it won't. Don't waste any time in getting the concrete into its place after water has been added—especially in hot weather; and if you are not able to get the whole batch in position before it begins to set, don't use what is left—it may be all right, but possibly it won't be. Don't mix very wet aggregate with cement and then allow it to stand for a long time before gauging. Don't take down the moulds or forms sooner than is absolutely necessary. Don't use a dry concrete for reinforced work and a wet concrete for concrete block work—the reverse is proper practice. Don't do any concrete work when it is freezing if it can possibly be avoided—but if not get the work done as quickly as possible and use warm water for gauging, and if the aggregate can be slightly warmed, so much the better.

Finally, don't, if the cement has complied with the requirements of the British Standard Specification, blame it if anything goes wrong—in 99 cases out of a 100 it is something else.

There are innumerable other questions connected with the subject of cement and concrete, but they scarcely come within the scope of this paper, and I will conclude by saying that there are few articles of commerce more useful to mankind in general than Portland Cement in its present state of, well, practically perfection, and that this is recognized is shown by the recent formation and flourishing condition of the Concrete Institute for the consideration of all subjects relating to cement and concrete.

Digitized by Google

# *THE R.E. HEADQUARTER MESS.*

(*Continued*).

*By* Lieut.-Colonel B. R. Ward, R.E.

Nearly all the plate in the Mess has been collected during the last 50 years. Two pieces only date from the period when the Mess was joint R.A. and R.E. One is a small silver snuff-box bearing the monogram R.A. surmounted by a crown, and the other is a ram's horn snuff-box bearing the inscription :—

Brompton Barracks
R.A. and E. Mess
From GEORGE SIM
Bengal Engrs.
An Hony. Member
Xmas 1844.

Since its establishment as a purely R.E. Mess in 1846, every campaign of any importance has been commemorated by a presentation of plate on the part of the officers who took part in it, and owing to this custom, fifteen of the principal campaigns of the last half-century are now commemorated.

The first of these is the Crimean Campaign, which is commemorated by a handsome silver vase mounted on an ebony pedestal, on the sides of which are three silver plaques embossed with views of places made famous by the campaign. On projecting corners of the pedestal stand silver figures of a R.E. officer, a sapper in field-service dress, and a sapper in working kit.

A beautifully designed representation of an elephant resting under a palm tree commemorates the Indian Mutiny, whilst the China Campaign of 1862 is marked by a handsome silver vase of Chinese design and workmanship, supported on silver dragons.

Silver vases mark both the Abyssinian and Ashanti Campaigns, and the Zulu War plate is a handsome silver trophy composed of Zulu assegais and shields, resting upon a silver pedestal embossed with representations of Rorke's Drift, Ulundi, and the Tugela. Round the base of the pedestal are kneeling figures of three different types of natives.

Afghanistan is commemorated by a chased silver vase, 24″ in height, and a circular basis. The vase is described on p. 215 of the *R.E. Journal* of 1884, and is richly carved with Indian engraved

Digitized by Google

work, interspersed with figures of R.E. and Sappers either engaged in action, on the line of march, or on work. The circular basis is engraved with representations of Kandahar, Kabul, Ali Musjid, and other places in Afghanistan.

A silver statuette of Cleopatra by Mr. H. H. Armstead, R.A., and exhibited in the Royal Academy in 1884, is a fitting souvenir of the Egyptian Campaign, and figures of Arabs resting under a group of date palms recall the Soudan Campaign of 1884.

The trophy for the Burma Campaign of 1885–87, is described on p. 261 of the *R.E. Journal* of 1889, as a silver vase "resembling a pepper pot with a pagoda top." The vase itself is 2′ 6″ high and is splendidly embossed with mythological and Burmese figures. It rests on a handsomely carved ebonized wood stand which is 2′ 3″ square.

The 1895 Chitral Campaign is commemorated by a cup which, with its base, stands 3′ high. On p. 259 of the *R.E. Journal* of 1895 it is recorded that the cup was made in Poona under the direction of Major (afterwards Colonel) O'Sullivan, R.E.

The long and severe campaign on the North-West Frontier of India during the years 1897–98, is marked by a handsome silver cup of Indian design, which is described on p. 110 of the *R.E. Journal* of 1901. It stands on an ebony pedestal, bearing shields inscribed "Mohmand," "Malakand-Buner," "Tochi," and "Tirah." Round the base of the pedestal is a silver scroll on which are engraved the names of the officers who served in the campaign, and at the four corners are silver figures representing a R.E. officer of the Queen's Own Sappers and Miners, a sapper of the Bengal Sappers and Miners, a sapper of the Q.O. Madras Sappers and Miners, and a havildar of the Bombay Sappers and Miners.

The three last campaigns to be commemorated are the Expedition to Pekin (1900–01), the South African War (1899—1902), and the Thibet Expedition (1903–04). Descriptions of these pieces of plate are given in the *R.E. Journals* of 1903 (p. 3), 1904 (p. 75), and the *Supplement to the R.E. Journal* of 1905 (p. 75), and are shortly as follows:—

The Pekin Expedition trophy is a silver model, 15″ long, of one of the two dragons which stand at the entrance of the Emperor's Hall of Audience at the Summer Palace, Pekin. It rests on a carved ebony base, the whole on an ebony pedestal, on the two long sides of which are the names of the officers who took part in the expedition, whilst at the ends are a record of the presentation and a description of the dragon.

The South African bowl is 13″ in diameter and 14″ high. The upper portion is surrounded by a design in relief of a veldt wagon drawn by 18 oxen. Standing at the four projecting corners of the plinth are four silver statuettes representing a sapper in field-service dress, a sapper engaged in entrenching, a young Boer, and an old

Digitized by Google

Boer. The ends of the plinth bear silver plates, on which the names of the principal battles in Cape Colony, Natal, the Orange Free State, and the Transvaal are engraved. In the curves of the plinth are silver panels typifying the work of the Corps, viz. :—(1), A pontoon bridge with oxen drawing a naval 4·7″ gun, escorted by mounted infantry, in the background a captive balloon; (2), a broken railway bridge of five spans; (3), a "Rice" pattern circular corrugated-iron blockhouse and a rectangular two-story masonry blockhouse, on either side of a river in hilly country; and (4), Sappers making a masonry and sandbag breastwork round a camp, in the foreground an armoured ox wagon and also an air-line.

The last of the pieces of "campaign" Mess plate commemorates the Thibet Expedition. It is a silver model of a "chorten" and was copied from a miniature in brass inlaid with turquoises which was presented to Sir J. Macdonald on his departure from Lhassa. It is worthy of note that the various portions of a "chorten" are said to represent the five elements as known to the Thibetans, viz., earth, air, fire, water, and ether.

In addition to these pieces of plate, commemorative of the various campaigns, are numerous pieces which have from time to time been presented either by officers on their retirement, or by units which have been associated with the Corps.

The principal of these pieces are the Burgoyne statuette, the piece commemorating the amalgamation of the Indian and Royal Engineers in 1862; Prince Arthur's Cup, presented in 1868; the silver pickaxe and stand, presented by Major W. Merriman in 1875; the Wilson Cup; General Grant's bowl; the Lindsay Cup and Casket; and a set of three fruit stands, originally presented to General Scott-Waugh. In addition to these may be mentioned a bowl of classical design presented in 1874 by the following Volunteer Engineer Corps:—1st Middlesex, 2nd Tower Hamlets, 1st London, 1st Hants, and 1st Northamptonshire; also a ram's head snuff-box presented by the officers of the 1st Lanarkshire R.E. Volunteers in July, 1900, and a cigarette case presented by the officers of the Special Service Sections R.E. proceeding to South Africa in April, 1901.

The Burgoyne statuette is a replica in silver of the statue by Boehm in Waterloo Place, which was unveiled on the 1st August, 1877. The statuette is 23″ in height, and stands on a pedestal 7″ high. The general effect is far better proportioned than is the case with the original statue in Waterloo Place.

The statue in Waterloo Place is lost under the shadow of the Duke of York's Column, and the pedestal dwarfs the figure. The statuette, on the other hand, rests on a pedestal of more artistic proportions and the figure is on a level with the eye instead of being too far above it.

Digitized by Google

A shield festooned with oak and olive leaves on the front of the pedestal bears the following inscription :—

JOHN FOX BURGOYNE,
FIELD MARSHAL, G.C.B.
BORN 1782—DIED 1871.
Erected by his Brother Officers of
Royal Engineers.
"How youngly he began to serve his country,
How long continued."
Coriolanus.

The back of the pedestal bears the Burgoyne arms and crest, the arms being surrounded by a circle bearing the motto of the Order of the Bath, "Tria juncta in uno," underneath it being a scroll bearing the motto "Ich dien." A shield on the right side of the pedestal bears the following inscription :—

WAR SERVICES.

| | |
|---|---|
| Malta. | Badajos. |
| Alexandria. | Salamanca. |
| Rosetta. | Burgos. |
| Passage of Douro. | Vittoria. |
| Salamonde. | St. Sebastian. |
| Busaco. | Bidassoa. |
| Elboden. | Nivelle |
| Ciudad Rodrigo. | Nive. |

Bayonne.
New Orleans.
Fort Bowyer.
Alma.
Balaklava.
Inkerman.

On the left side of the pedestal is a shield inscribed as follows :—

This statuette
copied from the
Memorial Statue
Erected in
Waterloo Place
is presented to the
Royal Engineers Mess
By the subscribers to the
BURGOYNE
Memorial Fund.

The words J. E. Boehm, A.R.A., Sculptor, and A. Hubert, Chaser, are engraved on the right upper portion of the pedestal.

The enumeration of his war services give but a faint idea of Burgoyne's claim to especial distinction in the Corps.

Digitized by Google

First of all Engineer officers to gain a Field Marshal's bâton—a rank to which he was gazetted on the 1st January, 1868—it was due to him more than to any other single man, that the Corps, after a period of comparative neglect when honours were few and military command unattainable, rose to a proud position of prestige which might well be the envy of foreign military engineers.

In the opinion of many of his contemporaries he occupied a place second only to the Duke of Wellington among the many distinguished officers who rose to fame during the most glorious period in the annals of the British Army. Sir William Gomm, for instance, writes to congratulate him on the 6th January, 1868: "I should have been better satisfied if I found the Government adding the Peerage to the Marshalship, as your just desert beyond that of any who have attained it from our ranks, save one, since the opening of the great French Revolutionary War."*

Lord Hatherton, a prominent Parliamentary figure during the earlier decades of the 19th century, who occupied the position of Secretary for Ireland when Burgoyne was Chairman of the Board of Public Works in that country, once remarked that he considered Sir John Burgoyne and Lieut. Drummond to be, without exception, the two ablest public servants he had ever met.†

A certain diffidence of manner and even of character appears to have militated against his personal advancement to the full height of reputation to which his great powers undoubtedly entitled him.

"If Burgoyne only knew his own value, no one would equal him,"‡ was said of him by the Duke of Wellington; but this in no way detracts from the value of his work for the Corps, nor can it lessen by one iota the honour in which his name and fame will always be held by his brother officers.

On his retirement from the War Office he wrote a farewell order to the Corps, which by permission of the Duke of Cambridge, Field Marshal Commanding-in-Chief, was read as a "General Order" at a full-dress parade of the Corps at Chatham, and which is sufficiently characteristic to merit reproduction *in extenso*.

"War Office, 17th January, 1868.

"Field Marshal Sir John Burgoyne cannot relinquish the post he now holds, without thanking the officers and men of the Corps of Royal Engineers for the cordial and efficient co-operation and support which he has always received from them, during the twenty-two years that he has held his present office, and at the same time expressing the great regret with which he bids farewell to the active superintendence of a Corps in which he will never cease to feel the deepest pride and interest.

* Wrottesley's *Life and Correspondence of Sir John Burgoyne*, Vol. II., p. 431.
† *Ibid*, p. 461.
‡ *Ibid*, p. 462.

Digitized by Google

"On such an occasion he cannot refrain from calling to mind the great changes that have taken place in the Corps since he first entered the Service.

"In the midst of the greatest war in which this country has ever been engaged, the Corps was held in such little consideration that it was without a single Sapper, had no recognized field equipment, and during prolonged campaigns with armies in the field, possessed only a few individual officers to carry on arduous sieges, entrench camps of magnitude, and perform all the varied and important duties of the Engineer Service.

"Nor were the duties in garrison or military stations better provided for, although the effects were of less importance.

"Those days are happily at an end; and the Corps now possesses a fine body of well-trained Engineer soldiers, fully instructed in every field duty, and is thoroughly competent to undertake any of the active services of war.

"As regards its ordinary peace duties, it has given proof of its efficiency in the control and management of the great works of defence considered to be necessary at home and abroad, and of which the design and execution are acknowledged to be at least equal to those of a similar character in any other country.

"An additional proof of the estimation in which the Corps is held, may be noted in the large proportion of its officers and men selected for extraneous positions of an arduous and responsible character under other branches of the Government.

"Much of the improved condition of the Engineer Service may be attributed to the spirit and exertions of its individual officers, but it is due in a still greater degree to the increased value which the progress of science has given to the special branches of the army, and to the higher appreciation with which the profession is regarded by the military authorities and country at large.

"After an association extending over seventy years, and comprising many periods of difficulties and hardships, Sir John Burgoyne takes leave of his comrades of all ranks, with the strongest sentiments of esteem, and with the fullest confidence in their future prosperity and distinction."

As senior officer of the R.E. in Spain at the close of the Peninsular War, and again as oldest officer of the three armies—Russian, French, and British—in the Crimea, he holds a unique position.

In addition to this, his record of service of over 70 years, commencing as a Second Lieutenant and ending as Field Marshal, Colonel Commandant, R.E., and Inspector-General of Fortifications, can never again be repeated. It is for this reason that his memory was specially honoured for many years after his death by his statuette being placed on the Mess table facing the President on guest nights. Subsequently this was discontinued and the latest campaign plate was given the place of honour. But the old custom has lately been revived, and the special honour is once more accorded to the man to whom the Corps owes so much, and whose position in it can never be usurped by any future Engineer, however famous.

Digitized by Google

Digitized by Google

The late Lieut.-Gen. Sir Richard Hieram Sankey, K.C.B.

*Reproduced, by kind permission, from a Photograph by MacMahon, Aberdeen, Strathpeffer.*

Digitized by Google

# *MEMOIRS.*

## *LIEUT.-GEN. SIR RICHARD HIERAM SANKEY, K.C.B.*

*By* 'H.M.V.'

LIEUT.-GENERAL SIR RICHARD HIERAM SANKEY, K.C.B., who died suddenly on 11th November, 1908, in his 80th year, was the fourth son of Matthew Sankey, of Bawnmore, Co. Cork, and Modeshil, Co. Tipperary, and Eleanor, his wife, daughter of Colonel O'Hara, J.P., of O'Harabrook, Co. Antrim.

Originally the Sankeys were an old Lancashire family, where the first known ancestor in King John's time was given a carucate of land in Sankey, near Prescott, to hold by military service, the line being unbroken to the present heir of Fort Frederic and Coolmore, near Clonmel.

In 1646 Sir Hyrome Sankey went to Ireland as one of Cromwell's generals and commander of the Parliamentary Cavalry, and for his services there obtained a large grant of land in the counties of Kerry and Tipperary. Under these circumstances it is scarcely surprising that Sir Richard Sankey, like his two elder brothers, chose the profession of arms.

He was born on 22nd March, 1829, at Rockwell Castle, Co. Tipperary, and was first educated by the Rev. D. Flynn in Harcourt Street, Dublin, and remained with him till he left for Addiscombe in 1845. From his earliest days he evinced a great talent for drawing, sketching everything that attracted his fancy, particularly animals, and his first silver medal was presented to him by the Dublin Society for the sketch of a cow which was in the show in 1845. He entered Addiscombe, February, 1845, and left with a commission in the Engineers, December, 1846, before he was 18. He carried off the first prize for painting. The head of his term was Duncan Home, who blew up the Cashmere Gate at Delhi, September, 1857; and another of his contemporaries was Geo. D. Willoughby, who blew up the magazine at Delhi on the outbreak of the Mutiny, May, 1857. His great talents as an artist were well known, everybody tried to get some specimen of his work to carry away, and there was a

Digitized by Google

current rumour that on his leaving the college, Fielding, the professor at Addiscombe, had offered him a handsome salary if he would give up his profession and join him as a teacher. He passed the usual time at Chatham, and did not reach Madras, to which Presidency he was posted, till November, 1848.

He was at once sent to the Sappers at Mercara, then commanded by Capt. J. W. Rundall, M.E.; but in 1850 he took up the officiating post of Superintending Engineer, Nagpore Subsidiary Force. This appointment he retained for three years, when he became very ill and went home for three years, not returning to Madras till 1856. During this time he resided a great deal abroad, in Germany and Switzerland.

He was now appointed Superintendent of the East Coast Canal, but in May, 1857, was sent up to Calcutta as Under Secretary, P.W.D., under Colonel Sir William Baker. On the breaking out of the Mutiny he was commissioned as Captain of the Calcutta Cavalry Volunteers, but in September following he was despatched to Allahabad for general field duties.

In addition to the completion of the defensive works along the Jumna, he had some heavy work in levelling the whole of the Allygunge quarter of the city (on which some 6,000 workmen were engaged), to clear the front of the entrenchments, and in addition to this he had to construct a causeway across the muddy bed of the Ganges some 1,000 yards wide, and to establish a bridge of boats for the crossing of the troops then expected from home. He was also specially charged with providing shelter for the bodies of advancing troops all along the Grand Trunk Road in N.W. Provinces, and while so engaged arrived at Cawnpore the day before that place was attacked by the Gwallior Force, under Tantia Topee. He acted as Assistant Field Engineer under General Windham, the C.R.E. being Lieut.-Colonel N. C. McLeod, B.E.

When the British force was driven back to its entrenchments he had of course the usual duties in the defence, and at this time he connected an outpost some 600 yards to the north by a simple screen of mats fixed during one night, and though the whole place was swept by fire, hardly a life was lost after the mats were put up.

The siege coming to an end with the defeat of the Gwallior Force on 6th December, 1857, Lord Canning appointed him Field Engineer to the Goorkha Force, under Jung Bahadur, to which General G. (afterwards Sir George) MacGregor, C.B., acted as Commissioner and Agent for the Governor-General. Only one other Engineer officer, Lieut. Garnault, B.E. (date of commission, December, 1855), lately arrived from England, was with the force, and between them they had to organize an Engineer Park at Gornekpore as best they could with scant materials and with the whole country disaffected. To provide means for the passage of the Gogra and the Goomtee on

Digitized by Google

the line of march to Lucknow required the collection of 120 large grain boats, which were towed up the first-named river under protection of Colonel Rowcroft's force, some 3,000 strong (consisting of the Naval Brigade and Goorkhas), and manufacturing a pontoon train from jheel boats (dug-outs) collected from all sorts of places, 100 miles off, and carried on carts to the Gogra with the main Goorkha force.

Sankey (quite alone) reconnoitred the river Gogra at Tandah, in view of effecting the crossing into Oude. On 19th February, 1858, the Gogra was crossed opposite Nowranee and the fort seized. The next day the action of Phoolpore took place, which caused the enemy to retreat. Owing to darkness, the success was not so great as it otherwise would have been.

At Phoolpore Sankey constructed the bridge of boats in $2\frac{1}{2}$ days. The bridge was 960′ long and 3 miles of road had to be made.

The next day the Goorkha Army, 20,000 strong, with 24 guns and 5,000 carts, crossed into Oude, and Sankey received the thanks of the Commander, as well as of the Government, for his "great and successful exertions on that occasion."

On 26th February, while on the march from Mobarakpore to Akbarpore, they were informed that at a small fort called Jumalpore there was a small party of rebels; troops were at once sent to attack it. The fort proved a very "hedgehog" of fortification, and very great difficulty was encountered in forcing an entrance. After a long time a gun was forced, with great labour, through the outer fence of bamboos into a position within 10 or 12 yards of the wall; another (a 12-pr.) and a third were placed at right angles to the first, and the cross fire thus produced was attended with the happiest results. "Lieut. Sankey, of the Engineers, who had been on the ground the whole day, discovered a small breach made by the first gun; it ceased firing. He enlarged the opening with his hands until it was sufficiently large to admit his head and shoulders, forced himself through it, and was the first man inside. The gallantry of this act, which I was an eyewitness of, I venture to bring particularly to the notice of the Brigadier-General."—Capt. Edmonstone's report. The Military Commander in his despatch to Government remarked: "The conspicuous gallantry of Lieut. Sankey was the admiration of every one; it was by his advice the gun was brought up which breached the wall, and he was the first man in the fort."

General MacGregor strongly recommended Sankey for the V.C. Lord Canning warmly supported the recommendation and forwarded it to England. This was considered informal, and it was referred back to India. Meanwhile Lord Canning had died. Sir Hugh Rose (then Commander-in-Chief) referred the case to a committee of officers, and they reported that "while considering the action a gallant one, yet from the circumstance of Major Sankey having been

Digitized by Google

made a Brevet Major while a subaltern, they could not support it." General MacGregor (brilliant services in Afghanistan from 1838 to 1842, and was granted C.B. and rank of Major for his services on these occasions) thus wrote: "The fact of Major Sankey having been made a Brevet Major one month earlier than he had a right to expect can hardly be looked upon as weighing in the balance against a decoration which in many respects is deservedly considered the proudest honour in the gift of the Crown. No man, in my opinion, ever better earned the V.C. than did Major Sankey. In the performance of his duty he exposed himself to almost certain death, setting a brilliant example of courage to the men who were engaged with him at the fort; and I may add with much truth that his services on this occasion contributed greatly to the capture of the place; and while it would be a mere act of justice on the part of Her Most Gracious Majesty to confer the V.C. on Major Sankey, it would be at the same time a delicate compliment to the memory of the lamented Earl Canning, who recommended Major Sankey for this honourable distinction." The authorities would not however move in this affair. As a matter of fact, Sankey was first made a Brevet Major on 20th July, 1858, but after some time it was discovered that being a subaltern at the time he had no right to it; it was changed to 28th August, 1858, the day after he attained the rank of Captain in the Madras Engineers.

How the date of a Brevet Majority could affect the question of a V.C. it is utterly impossible to understand, as Sankey would have obtained that, even had he not been present at Jumalpore. His services in bridging the Gogra and Goomtee, etc., would have sufficed to gain him the Brevet.

Sankey was present at the action of Kandooah Nulla on 4th March (mentioned), shortly after they had crossed the Goomtee, constructed the bridge for our passage at Sultanpore and received the thanks of the Government:—"Lieut. Sankey's exertions were as conspicuous as they were successful, and they merit the best thanks of the Government."

A few days after this the Goorkha force reached Lucknow and took possession, on the left of Sir Colin Campbell's force, of a suburb south-east of the Charbagh.

On the evening of 12th March they made an attack on the Charbagh. Next day a battery, under Sankey's advice, was established near the Hussain Gunge Bridge to enfilade the enemy's entrenchments with 12 guns. After two hours' heavy fire, the Goorkhas rushed over the entrenchment in their front and carried all before them to a point in the city $\frac{3}{4}$ mile south of the Kaiser Bagh. Lieut. Sankey was engaged with the Goorkhas in this attack, and while waiting with Lieut. Robertson at the point they had reached, they heard that Generals Franks and Napier had then carried the Kaiser Bagh, and at once

Digitized by Google

pushed on through the city with 80 Goorkhas, while the enemy was on the run (magazines exploding on all sides), to the gate of the Kaiser Bagh, where they reported themselves to General Franks. At night they returned by Banks' house and rejoined the Goorkha force.

On 15th Sankey was present with the Goorkhas in the attack on the enemy, who were threatening the Charbagh, and on the 18th and 19th the Goorkhas attacked the southern suburbs, this resulting in the final capture of the city. Lieut. Sankey made immediate arrangements for establishing the bridge over the canal near the Charbagh.

The bridge was made on 18th and 19th under difficult circumstances. The gap was 70′ wide and 38′ to 40′ deep, while the ripped-up roofs of houses only afforded baulks of 16′. After the 19th the Goorkhas had no more fighting; they encamped at Nawabgunge and soon marched back to Nepaul. Sankey, shortly after the siege, returned to Calcutta ill, and saw no further service. On 2nd July, 1858, he went on six months' leave to the Neilgherries, and before the close of the year married Sophia, daughter* of W. H. Benson, Esq., I.C.S. In 1859–60 he was Executive Engineer and Superintendent of Convict Jail at Moulmein, Burmah, for the management of which he received the thanks of the Government of India. In 1860–61 he became Garrison Engineer, Fort William, Calcutta, and in 1861–64 he was Assistant to the Chief Engineer, Mysore, Colonel E. Lawford, M.E. In this capacity his services were eulogized in the very highest terms by his chief, Colonel Lawford.

In 1864 he succeeded to the post of Chief Engineer and Secretary to the Chief Commissioner, Mysore. During the next 13 years he managed the Public Works of that Province in a most able and masterly manner.

The following account of his work there has been obtained from Colonel W. Chrystie, R.E., who was his assistant there for many years:—

"Sir Richard Sankey, being a man of unusual ability, original ideas, and untiring energy, left his mark on the country. Convincing the Government of India of the soundness of his views, he originated, in opposition to the views of the then Chief Commissioner, an Irrigation Department to deal scientifically with the old Native Works. Before his time the repair of the tanks was carried out as if each tank was independent of others in the same basin, but under Sankey's Tank Department the catchment area of each valley was surveyed, the area draining into each tank was determined, as also the discharge from the weirs of any tanks above. On these details, the length of weirs required for the tanks and height of tank were fixed. If water and

* Mrs. Sankey died 1882 at Ootacamund.

Digitized by Google

land were available, the capacity of the tank was increased. When the chain of tanks was very large (in one instance there were 700 tanks above the terminal one), what were called stop tanks were made where the conditions were favourable, *i.e.*, good rock available and the ground above flat, so as to give a good impound of water. The weir was then contracted in length, and the bank raised many feet above it, thus delaying the discharge of a large body of water and enabling the weirs of the tanks below to run off in exceptional rain-falls before the upper water came down. Of course, all the tanks in each chain were repaired at one time, and as each chain was completed the work was carried on to the next chain in the series. The other branch of the Irrigation Department dealt with the old native channels, which were very defective. Headworks were built, masonry distributories substituted for the pottery pipes, drainage carried over or under the channels instead of being allowed to fall into them, whilst the channels were surveyed, their defects of levels corrected, and the cross sections and falls made to carry the quantity of water required for the cultivation."

"The designs for the Great Maurai Kanvai work (since completed) were prepared by the late Capt. Pole, R.E., under Sankey's instructions. This work has a drainage basin of 1,250 square miles. Then as regards roads, the old ones were improved and new ones opened in all directions. Colonel Sankey's attention was especially directed to opening up the Mulnaad or Western Districts of Mysore, where previously almost all traffic had been carried on by bullocks."

"He caused to be constructed the Hyder Ghur Ghât, connecting the former city of Bednore with the coast. This place, the seat of a dynasty ruling all the low country at the foot of the ghâts, was sacked by Hyder Ali in 1763, when Wilks says a reasonable estimate of the spoil was £12,000,000. The capital, Bednore, never recovered this disaster and was called "hidden"; only one European, Capt. Le Hardy (who was Superintendent of Coorg in 1835), is said to have entered it between 1783, when General Mathews' force surrendered to Tippoo, and Colonel Sankey's first visit in 1866, when it was a hamlet of about 100 huts."

"Other ghâts were greatly improved, and roads running north, south, east, and west constructed, so that the whole tract of country was thoroughly opened out to wheeled traffic."

"Of buildings constructed in Colonel Sankey's time, the fine pile of Government offices at Bangalore is the most noticeable; the beautiful park which now surrounds it, was a piece of waste ground, cut up by nullahs so deep and steep that the troops practised escalading in them; these were sloped away, partly filled in, and further erosion stopped by numerous stone dams and paved drains. Colonel Sankey also greatly improved the quality of the water in the Ulsoor Tank, which at that time was the principal source of the water supply to

Digitized by Google

that part of the city. He collected the drainage of the native town above the tank into stone drains and conveyed it by a culvert under the Ulsoor into the Dumloor Tank."

"He also interested himself in the preservation of the ancient Dravidian temples, which are among the finest in Southern India."

In fact, he interested himself in everything which he considered would improve the condition of the country, and being most talented and an able administrator, he was most thoroughly successful in improving the Province in many ways, and the Mysoreans owe him a heavy debt of gratitude for what he did for them.

In 1870, while holding the post of Chief Engineer, at the request of the Government of Victoria, he was nominated by the Viceroy, Lord Mayo, to proceed on special duty to that colony. He went to Melbourne and made a full enquiry into the subject of the large reservoirs and distributary channels intended mainly for the supply of water for washing down the gold-bearing alluvium of several valleys. This duty, which was mainly that of an arbitrator, occupied him seven months, when he returned to Mysore. On the completion of the duty he received the thanks of the Government.

In 1877 Colonel Sankey was transferred to Simla as Under Secretary to Government of India, and in September, 1878, when war with the Ameer of Afghanistan appeared imminent owing to the rebuff of Sir Neville Chamberlain's Mission, Colonel Sankey was nominated C.R.E. of the force ordered to concentrate at Multan under Lieut.-General (afterwards Sir Donald) Stewart. From the first day of his appointment his energy and clear thinking were remarkable. General Stewart had not returned to India from furlough, and as Colonel Sankey was at Simla when preliminary arrangements for the campaign were being discussed, his opinion and assistance were sought at the Headquarter Offices, and he was daily in consultation with the Adjutant-General, Sir Peter Lumsden, and the Deputy Quartermaster-General (Sir Chas. MacGregor) as to the movement of General Stewart's force across the Indus, should an immediate advance into Afghanistan be ordered. On the 9th October, Sankey, with his personal assistant, Lieut. Childers, left Simla and reached Mooltan a few days later. Colonel Sankey set out immediately to find a suitable place for the division to cross the Indus, in the event of its being decided to make the advance through the low hills which lie between that river and Dadur, at the mouth of the Bolan Pass. From the 17th to 27th October he was up and down the river between Kashmore and Mithenkote, examining all the likely landing places, and riding inland on either side. He and his assistant had to follow country paths, which seldom failed to take them through some swamps. The Indus, always unmanageable in flood, was this autumn worse than usual. In making their way after dark from the river bank to Nowshera Station, on the Indus Valley Railway, they found

Digitized by Google

no track and had to pick up local guides to lead them from village to village through the muddy swamp, and with no moon this was not exactly a cheerful task; but Colonel Sankey was always cheery and his extraordinary energy carried all before it. On his return to Mooltan on 27th October, Sankey found General Stewart arrived from England, and learned moreover that the reply of the Amir was decidedly unsatisfactory; the pontoon and telegraph companies of the Sappers and Miners had arrived from Roorkee and the two siege batteries were coming in.

It may here be remarked that General Stewart's Division was equipped originally to proceed to Herat. General Stewart at once held a council, and after receiving Colonel Sankey's report and advice, it was decided to give up the idea of crossing the Indus near Mithenkote, but to push on all stores and material and to arrange for the transport of troops by Sukkur and Jacobabad—the old route of the Army of the Indus in 1839.

During the following three weeks Sankey, with the rest of General Stewart's Staff, were working hard at the organization of their various branches. A Field Engineer Park was created, and placed under Lieut. (now Colonel) Call; the Sapper companies were sent off in advance by rail to Sukkur, whither the rest of the division were gradually following, and on the 18th General Stewart, with Sankey and the rest of his Staff, crossed the Indus at Sukkur, and moved with his division across the Scinde Desert from Jacobabad to Dadur, reaching Quetta (through the Bolan Pass) on 12th December. Long before this the Amir had rejected the ultimatum, Ali Musjid had been captured, and General Stewart was now anxious to surmount with his division the only remaining barrier (the Khwaja Amram Range) between him and Candahar.

Colonel Sankey accordingly was again sent forward to examine and report, and as a result of his energetic explorations, was able to recommend an entirely new and hitherto little known line of advance by the Khwaja Pass, a route which was at once adopted by General Stewart, and which enabled him to move his 1st Division with the heavy guns speedily and easily, leaving the Khojak available for the use of the 2nd Division, under General Biddulph. It did not take General Stewart long to realize the value of Sankey's ability, and the influence of the Commanding Engineer in the counsels of the General was very marked throughout the whole of this campaign. Power was given to Sankey to go ahead and work in his own way, in preparing the roads for the advance of the army. A brigade of native infantry, with a British infantry detachment, as well as the Sappers and field park, were placed under his immediate orders, with a view to push on all works as he should think best for the general advance of the army towards Candahar.

"The plan of giving Colonel Sankey power to go ahead and work

Digitized by Google

his own way with the regiments at command for work is a sound one," wrote Colonel Le Messurier, "and will settle many misunderstandings as to the position of the Commanding Engineer and his officers."

The Candahar Field Force was fortunate in having a Commanding Engineer who possessed the entire confidence of his General, and of a General who was able to appreciate so accurately the valuable qualities of his Engineer Adviser.

On the 3rd January, 1879, Sankey, with his advance force, came up to the cavalry under General Chas. Palliser at a place called Hauz (General Palliser received a sabre cut at the Battle of Sobraon, and highly distinguished himself during the Mutiny; was afterwards a G.C.B.), about two marches from Candahar, and next morning advanced with General Palliser to reconnoitre the front; a body of Afghan cavalry came out to oppose this advance, and near a village called Takt-i-Pul a cavalry fight took place, the only action of this theatre of the war.

Candahar was immediately afterwards occupied, and after a ten days' halt, General Stewart continued his advance towards Cabul, but got no further than Kelat-i-Ghilzai, as the flight of Shere Ali put an end for a brief period to the war in Afghanistan. General Stewart returned with his 1st Division to Candahar, where he and his Staff were soon deep in consultation settling the arrangements for the hutting of the troops during the coming hot weather. Surveys were ordered to be made, questions of water supply discussed, and committees sat daily, over which the powerful and active mind of Sankey exerted a preponderating influence. In the midst of this arduous work Sankey received a telegram offering him the appointment of Secretary to Government of Madras in the Public Works Department, and to the regret of the whole Staff he left Candahar and returned to India.

Although he was able to carry out during this campaign a great amount of valuable work, in which his time must have been constantly employed, he yet found leisure to make many valuable sketches of the country, and two of his sketches of Kelat-i-Ghilzai are published in the *Life of Sir James Browne, K.C.S.I.*, by Major-General J. McLeod Innes, V.C., C.B.

Colonel Sankey received the medal for the campaign and was appointed Companion of the Bath.

On 8th April, 1879, he reached Madras and took up the post of Chief Engineer and Secretary to Government. Here he again evinced his remarkable talents and energy. The following tribute to Sir Richard Sankey's work as Chief Engineer at Madras has been sent to me by Colonel J. Pennycuick, C.S.I., R.E., who was his Under Secretary during most of the time he served as Chief Engineer :—

"I was Under Secretary during three years of the time he was

Digitized by Google

Chief Engineer, and was in unusually close personal and official relations with him.

"I had the highest admiration for his administrative powers, and especially for his capacity of managing and judging men. He entered office under the serious disadvantage of having been absent from the Madras Presidency for about 20 years, and consequently knew but little of the personal affairs of the Department. A very short time however served to remove this difficulty.

"It so happened that during his tenure of office the Madras Public Works Department had to be completely reorganized twice over. In 1879–80 the Government of India, in one of their periodical attacks of economy, insisted on a reduction of the Superior Staff to an extent that rendered efficient administration a physical impossibility, with the natural result that in less than two years they were obliged to consent to an expansion of the same Staff to somewhat more than its former strength. The masterly manner in which Colonel Sankey dealt with the re-distribution of duties and charges rendered necessary by this double change, and the way in which he managed the long and highly controversial correspondence which preceded it, can only be appreciated by one who, like myself, was intimately acquainted with every detail of the business.

"Of his more personal characteristics, of his unfailing kindness and courtesy, his loyal support and ungrudging encouragement of every man who worked under him, I cannot even now think of without emotion; my own feeling towards him was one of little less than adoration."

While Colonel Sankey was at Madras he was elected Fellow of the Madras University and appointed a Member of the Legislative Council, and not content with all his onerous duties, he interested himself in the improvement of Madras, and was most active in forming the Marina and beautifying Government House grounds and the Botanical Gardens.*

Towards the close of 1883 he went to England, and on the 1st January, 1884, was appointed Chairman, Board of Works, in Ireland, and here in an entirely new field he again showed his talent, versatility, and energy, and his great powers as an administrator.

The title of that body conveys little idea of the variety and extent of the duties attached to it. It discharges all the functions in Ireland discharged in Great Britain by the Office of Works as regards the building, maintenance, and providing with supplies of all civil offices, with the addition in Ireland of some military, all Coastguard and Naval Reserve buildings, and the maintenance of the Royal

* Sir Richard Sankey received the reward given to officers for distinguished services.

Digitized by Google

University, Queen's Colleges, and all National Schools, numbering 935, vested in the Commissioners of National Education. As successor to the Shannon Commission it controls the whole of the non-tidal portion of that river for drainage and navigation purposes. It is the central authority for allowing the carrying out of arterial drainage schemes by local drainage boards and securing their maintenance. It has charge of the five Royal Harbours of Kingstown, Howth, Ardglass, Donaghadee, and Dunmore, and builds fishery piers and harbours for transfer to local authorities.

The management of the Phœnix Park and St. Stephen's Green Park, Dublin, and other open spaces is in its hands, and under the Irish Church and Ancient Monuments Acts it has to maintain some hundreds of ancient and national monuments. Its functions as regards works are sufficiently wide, but in addition it was, prior to recent land purchase legislation, the chief Government lending authority in Ireland, with functions much wider than those of the corresponding body in England, covering not only loans to local authorities for public health purposes, and to railway companies, but loans to landlords for the improvement of their estates and to tenants for the improvement of their separate holdings, so that the Board may on the same day be dealing with a loan of £50 to a tenant farmer in Connemara and a loan of a quarter of a million to the Corporation of Dublin. General Sankey was appointed to the supervision of this heterogeneous collection of duties at a critical time. The country was in a very disturbed condition and the Department was exposed to searching and often very unfair criticism. Fresh duties were imposed by the Irish Land Act in 1881, by the Tramways and Public Companies Act in 1883, and by the Sea Fisheries Act for construction of piers and harbours with the Irish Church Fund of £250,000.

Amidst this pressure, caused by the creation of these Acts, the ability, energy, and professional skill of the Chairman made themselves felt in the acceleration and improvement of the work of the Department, where every officer felt that, while his chief demanded much from him, he was unsparing of his own exertions, and could be trusted to stand by his Department, if unfairly attacked, through thick and thin.

Before April, 1886, the engineering merits of nearly 60 tramway schemes had been reported on, of which 30, covering 428 miles, received the approval of the Grand Juries, and baronial guarantees.

Every year saw more fishery piers in construction, and by 1890 57 had been built and four more nearly completed, at a cost of £253,000, often on the most out-of-the-way parts of the coast.

Arterial drainage is a matter of immense importance and interest to Ireland, and the general supervision of it is one of the chief branches of the duties of the Irish Board of Works.

Digitized by Google

With regard to the Lough Erne Drainage Scheme, it fell to General Sankey to defend the part played by the Board, and in another, the river Suck, he was actively concerned in the negociations of the arrangements which enabled it ultimately to be carried through.

The most important river in Ireland, the Shannon, is in actual charge of the Board of Works for canal navigation and drainage purposes. A Parliamentary Grant was made for improving the control of floods by means of sluices, and General Sankey took an active part in carrying them to a successful conclusion. His interest in the river never flagged, and a few years later he was largely concerned in the obtaining of a grant for additional works at Killaloe and Lough Allen, by which the control of the river was still further improved.

In 1889 the Government passed the Light Railways Act. As a result of this there was a great crop of schemes, and it was the duty of the Board to report on their relative merits. Prolonged and difficult enquiries were carried out under great pressure of time. The most important of these enquiries covered the counties of Donegal, Mayo, Galway, and Kerry. Agreements were necessary in each case between the Treasury and the promoting company. In their preparation General Sankey took a principal part. It is sufficient proof of the excellence of the work then done that in 1896, when further assistance was given by Government for railway extensions, scarcely any changes were required to be made in the provisions of the agreements.

General Sankey's interest in art and his skill as a painter both in oils and water colours were evidenced long before he came to the Board of Works. His work with buildings did not afford wide scope for his artistic sympathies, but in one field the work of the Board was highly congenial to him. The Irish Church Act had handed over a large number of ecclesiastical buildings to the Board for preservation as national monuments. General Sankey had the principal part in the administration of these Acts, and he devoted himself to the work with energy and enthusiasm.

The credit belongs to him of proposing and inducing the two principal Antiquarian Societies in Ireland to fall in with the proposal that the work of the Board should be carried out with the aid of a consultative committee, on which both societies should be represented. The happiest results have followed from this arrangement.

There is one other branch of the Board's business to which General Sankey was attracted by his love of nature and art, and that is the care of the two parks—St. Stephen's Green Park in Dublin and the Phœnix Park on its outskirts. Looking after these parks was an occupation he never wearied of, and he made a practice of visiting

Digitized by Google

them nearly every week and studying on the ground with the bailiff in charge every proposed new work.

Under his fostering care the park retained its true park-like character, without interfering with which there was developed in the park nearest to the city a garden, in which at every season of the year those interested in horticulture are delighted by landscape gardening in its highest developments. It only remains to speak of General Sankey as a member of the Board and the head of a large staff of officers. His ability, energy, his sincerity of purpose, and the absolute absence in him of self-seeking won the admiration and respect alike of his official and political chiefs, and of his colleagues and his subordinates, and these feelings deepened into personal liking and even affection in those who were brought into close relation with him. Many of those associated with him passed away before his death, but to those who survive his kindly personality is a cherished remembrance.

Sir John Barton writes that although his official duties as Chairman of the Board of Works were so important and onerous, General Sankey, owing to his gift of organization, was able to find time to devote to other interests which would benefit his fellow men. One of these was the Royal Zoological Society of Ireland.

His knowledge of zoology and interest in the well-being of the animals, especially the birds, combined with the fact that he was an experienced engineer, was of great value to the Society, both in the purchase and care of the specimens and in the building of new houses.

General Sankey held the post of Chairman of Board of Works for 12 years, his period of service having been extended two years beyond what is customary, owing to the great value of his services. On the occasion of Her Majesty's birthday (24th May), 1892, he was gazetted a civil K.C.B., being already a military C.B. He retired from the post of Chairman in 1896 and went to reside in London. His active mind did not permit him to remain without taking the very greatest interest in many matters with which his career had been connected, such as irrigation in India, improvement of Ireland, Navy League, etc., and he paid a visit to Mexico, and after had much correspondence with reference to that country with the celebrated President, General Diaz.

I have received a considerable number of letters from officers who knew him intimately, and they all unite in eulogizing General Sir Richard Sankey's ability and character. It will suffice to give two of these, which to my mind sum up the active, versatile, and brilliant character to which I hope this compilation does sufficient justice.

Sir Harry Prendergast, V.C., G.C.B., writes: "I think Sankey was the most brilliant officer of the Madras Engineers during the last half-century.

Digitized by Google

"As a military officer he was eminently distinguished by his skill and extraordinary bravery. His services as a Civil Engineer were very conspicuous. He was a born leader of men, whatever his hand found to do he did it with his might; he deserved and obtained the confidence and affection of the officers and men who worked under him, and thus secured their best and most enthusiastic support and reverence. He was an accomplished painter in oils and water colours, enjoyed a run with the hounds at Ooty and a game of polo at Bangalore, he was a deep thinker and a diligent reader, a charming companion, beloved by men and women."

Colonel W. Chrystie, R.E., who served under him for many years, writes: "In person he was of fine physique, absolutely untiring. He was a fine artist, an excellent companion, a very desirable friend, and a very undesirable opponent."

Sir Richard Sankey married, in 1890, Henrietta, daughter of P. Creagh, Esq., and widow of Ed. Browne, Esq., J.P. Lady Sankey survives him.

Digitized by Google

# *MAJOR PERCY BRAYBROOK MOLESWORTH, R.E.*

*By* Capt. P. Robinson-Embury, late R.E.

Major Percy Braybrook Molesworth passed away at the Naval Commissioner's house at Trincomalee, Ceylon, on Christmas Day, 1908. His death was a great shock to many, and a personal loss to his friends, for not only was he one of the best hearted of men, but his character was an example to all in its fearless honesty and uprightness.

He was born at Colombo in 1867, his father—Sir Guilford Molesworth—being then the Engineer-in-Chief of the railway in course of construction to Kandy. He was educated at Winchester College, and obtained his commission in the Corps of Royal Engineers in February, 1886.

After passing through the S.M.E., Chatham, he specialized in submarine mining, and was stationed at Fort Camden, Queenstown Harbour, until 1891, when he was ordered to Hong Kong for three years. After his return, finding he could not stand the English climate, he volunteered for service in Ceylon, and was sent out there to perfect the defences of Trincomalee Harbour.

In 1898 he joined the B.A.A. Solar Eclipse Expedition to India, and towards the end of that year he was temporarily seconded in order to act as Secretary to Sir Guilford Molesworth, and to visit and report on the Uganda Railway on behalf of the Foreign Office, returning to Trincomalee about the middle of 1899.

He obtained his majority in 1904, and retired in 1906, after 20 years of service.

During the time that Major Molesworth was in the Royal Engineers he was very keen on his regimental duties and trained his men to a high state of efficiency, and was greatly beloved by them. On his retirement the non-commissioned officers and men of his company wrote to Lady Molesworth, expressing their great appreciation and enclosing a picture of him and of the whole company. On his death, three years later, it was the desire of the native sappers of his company that they should bear his remains to their last resting place, and accordingly his coffin was carried by six of his native sappers.

Inheriting a large share of his father's well-known talents, he ever associated himself with matters of scientific bearing, and from his youth up made a special study of astronomy—particularly connected

Digitized by Google

with the planets Jupiter and Mars. On these he made some very important and valuable memoirs, many of which have been published in the B.A.A. Papers. He was the first to detect, in February, 1901, the beginning of what has since become one of the most important and interesting features of the planet Jupiter, the great disturbance on the South Tropical Zone.

He was a wonderful draftsman, and the amount of care and trouble expended on his work can only be fully realized by those who have had an opportunity of studying his original entries and drawings.

Trincomalee, with its wonderfully clear atmosphere, is an ideal spot for astronomical observations, and this, together with the fact that the climate suited Molesworth's constitution, were the main factors which induced him to purchase estates in the neighbourhood on retiring from the Service. Here he settled down with his brother Guy, developed the land and cultivated various products, including cocoanuts, rubber, tobacco, and cotton. The hard work entailed in starting the estates prevented him, unfortunately, from continuing his astronomical observations. His death is doubly sad as it occurred just as he had brought the estates to paying condition, which would have allowed him sufficient leisure to continue his well-beloved study.

In addition to the estates, the two brothers established a motor-boat service from the mouth of the Mahavelli Ganga, where their estates were situated, across the harbour to Trincomalee, and this did a great deal in opening out that part of the country.

Retiring and somewhat shy, but unassuming to a fault, Major Molesworth yet possessed a charm of manner and personality peculiarly his own. His quickness of brain, added to his naturally scientific bias, made his views not only deeply interesting in his exposition of them, but far sighted.

His death in the prime of life is a great loss to the Corps, and has taken from those who knew him personally a good and true friend, of a lovable and sterling character.

Digitized by Google

# *TRANSCRIPT.*

## THE TRAINING OF THE 7TH ENGINEER REGIMENT OF THE FRENCH ARMY.

Translated from an article by Capt. D. Honorato Manera Ladico,* in the *Memorial de Ingenieros* for September, 1908.

THE 7th Regiment is composed of four battalions, one engineer transport company, and one fortress company. Each battalion is divided into three companies. The battalions are numbered 12, 13, 15, and 19, the numbers indicating the army corps to which each is attached in case of mobilization or manœuvres. In each battalion the 1st Company belongs to the 1st Division of the army corps, the 2nd Company to the 2nd Division, and the 3rd Company to the corps troops. In peace time the four battalions and the engineer transport company are stationed at Avignon. The fortress company, which has a special organization (not dealt with in this article), is at Nice and in the forts in its neighbourhood. The regiment is commanded by a colonel, assisted by a lieutenant-colonel and a major, and each battalion is commanded by a major.

Attached to the regiment, and under the orders of its commanding officer, is the "Ecole du Génie d'Avignon," which is in charge of the engineer parks and stores and of all the equipment of the school of instruction, and which has a major in command.

In the French Army all the recruits join the colours during the first ten days of October. This is to allow of the recruits being trained by the spring, as spring and summer are considered the most likely seasons for a campaign.

The recruits are allotted to the engineers in accordance with their height, trade, degree of education, etc. On arrival at the barracks they are classified in two groups—combatants and auxiliaries. The latter receive only a limited amount of training, and after one month are drafted to fill vacancies as clerks, orderlies, tailors, shoemakers, etc. In 1907 some 75 recruits were posted to each company (60 combatants and 15 auxiliaries). The two classes are trained separately.

The French soldier is drilled every day, commencing at 5.30 a.m. in summer and 6.45 a.m. in winter. Drill lasts until 9.30 a.m., at which hour the troops breakfast. Work is continued in the afternoon from 1 p.m. to 4.30 p.m. Dinners are at 5 p.m. The men are given coffee before the early morning drill.

During the first fortnight of their service the combatants of each company of the four battalions are instructed in infantry drill and gymnastics

* Capt. Ladico was attached to the 7th Engineer Regiment at Avignon for nine months.

Digitized by Google

only. Commencing in the third week, half the day is devoted to drill, and the other half to technical instruction. The recruits' training continues until March, after which it is combined with that of the old soldiers. At the end of the first week a rifle and knapsack are issued to the recruits, and these they always take with them when marching from barracks to the drill ground, when at drill, or when practising—as they frequently do—the passage of obstacles whilst in marching order. When technical work is to be done, arms are piled and knapsacks taken off, that is to say the French soldier puts on his equipment, including his portable entrenching tool, four times a day (twice in the morning on going to and returning from the drill ground, and twice in the afternoon). This produces excellent results, because the soldier is so accustomed to his equipment that it becomes quite natural to him to carry it. After the first few weeks of instruction, all tactical movements are always executed in marching order.

The various branches of the technical instruction are combined in such a way that all are learnt simultaneously. For example, a company will devote Mondays to earthworks, Tuesdays to demolitions, Wednesdays and Fridays to pontoon bridging, and Thursdays to spar bridging. There is no drill on Saturday afternoons, which are devoted to inspection by the subaltern in charge of the section. Almost every Saturday morning is spent in battalion drill, and during the last hour all the battalions are united under the command of the lieutenant-colonel, and march past before the colonel of the regiment. As soon as the recruits are able to march and to carry their rifles correctly, they join the old soldiers for battalion drill, but they do not take part with them in other drills and exercises.

Technical instruction is carried out relatively slowly, each subject being thoroughly mastered. On arrival at the fieldwork ground, arms and equipment are taken off, and the men are divided into small squads under a N.C.O. or old soldier, who first gives an explanation, then questions the men about it, and finally sees it practically carried out. For instance, during the instruction in demolitions, when mélinite bombs are being dealt with, the N.C.O. first describes them in detail, and then questions each recruit on the subject. The latter handle them and make themselves thoroughly familiar with them. The detonators, fuzes, method of making joints, etc., are then explained. The officer of the week supervises the instruction of each group, and frequently takes one of them himself. The captain is responsible for the instruction of his company, and is present whenever he thinks it necessary. Both the field officers and captains attend very frequently at the fieldwork ground.

In teaching fieldworks, a commencement is made by giving the recruit a succinct account of the different kinds of earthworks which have already been made on the fieldwork ground; after that they are set to make trenches, gabions, etc. Instruction in these subjects is alternated with practice in crossing obstacles, first without arms, and afterwards in marching order. No attempt will be made to give a full description of the courses of instruction, but a few points of interest will be noted. It should be stated that six to seven hours daily are devoted to the work.

Digitized by Google

In mining the various kind of mines are first explained, and afterwards galleries, shafts, etc., are constructed.

In demolitions the men are thoroughly instructed in the use of mélinite, detonators, fuzes, jointing, use of the exploder, etc.

In pontooning the recruits are first made acquainted with the two types of pontoon which are employed—namely, the wooden and iron pontoons—with the mode of loading and unloading, method of launching and taking out of the water, rowing, poling, formation of bridge, mooring, etc.

In the month of April the recruits join the old soldiers and practice *elementary instruction*, drill and technical work being taken in turn.

A fortnight before the arrival of the recruits a squad is formed of aspirants to non-commissioned rank. Men to join this squad are selected from every company in accordance with their educational and other qualifications. Only one such squad is formed for the whole regiment, and it is placed under the command of a captain, assisted by two subalterns. The squad formed during the time that Capt. Ladico was attached to the regiment numbered at first 180, but little by little those men were eliminated who proved themselves unsuitable. Thus in some years it is difficult to obtain promotion to the rank of corporal. This squad is put through the same course of instruction as the recruit squads, but as it is formed of picked men it progresses much more rapidly.

In April, when the recruits join the old soldiers, the *elementary instruction* consists in the execution of various types of earthworks, all kinds of hasty bridges, and small demolitions. Water work receives special attention; rafts, sections of bridge, and bridges across the Rhône are made. During this period drill is only carried out once a week, namely, on Saturday mornings, the first hour being devoted to section and company drill, and then battalion drill. On the other days of the week the men are on the works both in the mornings and afternoons.

Each battalion carries out a route march once a week, dinners being cooked in the field. Each route march is executed in accordance with a previously issued scheme, and technical engineer works are carried out on the ground during the march. These exercises are considered to be of great importance, and will be described on another occasion. Field firing is frequently practised, generally once a week.

Every battalion goes under canvas for a fortnight, during which period mining is practised.

At the end of May battalion technical manœuvres take place. One divisional company is formed from all the men available, and carries out a definite scheme in which the company forms part of a column engaged in some tactical operation. These manœuvres usually last four days, during which the engineer works required for accomplishing the tactical conditions are executed. The officers also prepare sketches, reconnaissances, and projects, and perform other military and technical duties. The battalion is billeted in the villages.

As soon as all the battalions have finished their technical manœuvres, they are united in order to carry out regimental technical manœuvres (1,000 men took part in them in 1907). In these only a few engineer works are undertaken, attention being specially directed to purely military

Digitized by Google

operations; thus of the four battalions three act as infantry, and only throw up such entrenchments as would be made by that arm. Open order drill and the infantry combat are practised, and the regiment is billeted in one or more villages.

During July each battalion has its pontooning manœuvres, which last four days. All the men (in the battalion mentioned there were 250 pontoniers) are engaged on bridging duties on the Rhône. At the end of these manœuvres the men of each company are divided into two groups for higher training, some being detailed as sappers and miners, and others as pontoniers. They all remain in the same company, and in it receive higher training in the group of subjects in which they specialize. Thus all the men receive the same complete elementary training, and afterwards higher training either in fieldworks or in pontooning. The pontoniers go down to the Rhône every day, both morning and afternoon, and practice nothing but pontooning. The sappers and miners go to the camp of Villeneuve-les-Avignon, where they continue the instruction in mining commenced by all during the first period of training, assisting at explosions and mining exercises which take place in August.

During the same month the pontoniers of the regiment under a major and other officers, carry out special manœuvres on the Rhône—in 1907 they lasted four days, and 280 pontoniers were trained—make numerous bridges, and are billeted in the villages.

At the end of August competitions are held for N.C.O.'s and men. In 1907 the subjects were earthworks, four-legged trestles, water work, and pontooning. The winner is the man who executes his task in the best manner and in the shortest time. The company which gains most prizes is honoured by being detailed as escort to the colours.

Afterwards the inspection of the Chief Engineer is held. In 1907 it lasted six days, during which he witnessed all kinds of technical and military exercises, inspected the barracks, fieldwork and training grounds, and distributed prizes to the winners of the competitions.

Each divisional company takes part in the evolutions of its own division. That to which the writer was attached trained with the 23rd Division at the camp of Courtine (department of la Creuse) at the end of June and beginning of July. Six thousand men were present, of whom 110 were engineers.

The grand manœuvres of 1907 took place in the first fortnight of September in the departments of Dordogne and Charente. The writer's battalion was attached to the 12th Army Corps. It and the 18th Corps numbered together 35,000 men, of whom 750 were engineers. Leave was given at the end of the manœuvres.

In the divisional companies there are more sappers and miners than pontoniers; the opposite is the case in the corps troops company. The companies attached to the Alpine divisions practise a great deal with the Yarron and Eiffel bridges (without intermediate supports), so as to be able to use them in the ravines of the Alps.

The recruits told off to the engineer transport company receive a special training in riding, harness, vehicles, and all kinds of transport duties.

'M.'

Digitized by Google

# *REVIEWS.*

## THE LIFE OF MAJOR-GENERAL SIR JOHN ARDAGH.

*By* Susan, Countess of Malmesbury (Lady Ardagh).—(Published by Mr. J. Murray, 1909).

Lady Malmesbury deserves the thanks of the Officers of the Royal Engineers for having written this interesting memoir of their distinguished brother officer, Sir John Ardagh, who had the advantage of being closely connected with several important episodes in the history of Great Britain during his military career. With great discretion she has included much of what Ardagh wrote himself, and his observations on the events of which he was an eyewitness show him to have been a shrewd judge of men and matters.

At a comparatively early age he had an opportunity of proving his resourcefulness under difficulties when, as a subaltern of two years' standing, he was ordered to Canada in command of a detachment of Royal Engineers, at the time that relations with the United States had become strained in consequence of the high-handed action of the Federal Government regarding the arrest of Messrs. Slidell and Mason. Ardagh and his men embarked in the s.s. *Victoria*, a vessel which had been hired as a transport, although totally unfit for an Atlantic voyage, as the rigging was in bad order and the engines weak and defective. Meeting with heavy weather, the ship lost her sails and sprung a leak; then, to make matters worse, the engines broke down and the pumps refused to work. Had it not been for the energy of Ardagh and his sappers, all on board would probably have been lost, but he succeeded in tinkering up the engines, rigging jury pumps, and at last the *Victoria* was brought back to England in safety, after having been three months at sea. Ardagh's services were so conspicuous on this occasion that on his return to Chatham he was publicly thanked on parade by order of the Commander-in-Chief.

During the time that Ardagh was having his perilous voyage in the Atlantic the war cloud had blown over, as the United States Government had yielded to the British demand for the surrender of Slidell and Mason; his orders to proceed to Canada were therefore countermanded, and he was sent to the Southern District for duty on the fortifications, which were then in course of construction at Portsmouth and at Newhaven under the Defence Loan of 1860. He was principally responsible for the design and construction of the works erected for the protection of

Digitized by Google

Newhaven Harbour, and showed such ability in all matters connected with fortifications that in 1868, when a Commission was appointed to inspect and report on the works that were in course of construction under the Defence Loan, he was selected to act as Secretary, and accompanied them on their tour of inspection round the United Kingdom. He was next chosen to go with Sir William Jervois on a visit to the defences of Halifax and Bermuda, and on his return was appointed Secretary of the Committee on Coast Defences. In these different positions Ardagh had the opportunity of becoming thoroughly acquainted with British defences, knowledge which proved of great use to him later, when he joined the Intelligence Department.

But his studies were not confined to the fortifications of the United Kingdom, as in 1869 he was sent to Holland and Belgium to report on the defences of those countries; and in the spring of 1871, having obtained leave to travel in France, he arrived in Paris just after the armistice was concluded between the French and Germans, and as soon as peace was concluded he took the opportunity to visit the forts round Paris. From Paris, Ardagh went on to Besançon, Belfort, and Strasburg, and returned to England by way of Germany after a very instructive tour.

After a short period of service at Malta, where he was struck down by the much-dreaded Maltese fever, now fortunately a disease of the past, he was invalided home, and in 1872 passed the entrance examination to the Staff College, and when his course of instruction there was completed was selected for employment at the Intelligence Department of the War Office, of which General Sir P. Macdougall was then the head. He spent a little more than a year at the War Office, and in 1876 was chosen for special service under the Foreign Office in connection with the affairs of the Near East.

It was a period of great excitement in Turkey and in the Balkan Peninsula. Insurrections in Herzegovina, Bosnia, and Bulgaria led to the deposition and death of the Sultan, Abdul Aziz, and to his succession by the Sultan Murad, who in his turn was deposed and succeeded by the late Sultan, Abdul Hamid. In July, 1876, Servia declared war against Turkey, and in the following month, after some severe fighting, the Turkish Army entered Servia, when the latter State appealed to the European Powers to interfere on its behalf, and an armistice was arranged, so as to allow of the question being settled at Constantinople.

General Sir Arnold Kemball was British Military Attaché with the Turkish Army which had entered Servia, and Capt. Ardagh was ordered to join him at Nisch, where the Turkish headquarters were then established. Leaving London at the end of August, he proceeded to Vienna, and by steamer down the Danube to Belgrade and Widin, whence he had a rough journey across the Western Balkans to Nisch. Here he found the Turkish Army extended along the left bank of the Morava River and facing the Servian position in front of Deligrad-Alexinatz on the right bank, and notwithstanding the armistice, the Servians were frequently firing at the Turks, who had instructions not to reply. At length a deliberately planned attack compelled the

Digitized by Google

Turks to drive off their treacherous enemy, which they succeeded in doing without much difficulty.

On the conclusion of the armistice the Turkish Army advanced, completely defeated their opponents, and made themselves masters of Servia, when Russia interfered, and a further armistice was agreed to.

Ardagh however did not see the conclusion of the struggle, as he was summoned to Constantinople to assist Colonel Home, R.E., in preparing a scheme for the defence of the Turkish capital by a line of fortifications from Buzuk-Tchekmedji, on the Sea of Marmora, to the Black Sea, and in making other surveys in connection with the defences of the Bosphorus and the Dardanelles. After the completion of this duty he was sent to Bulgaria to report on the state of the country, which was in a very disturbed condition. A few months later Russia declared war against Turkey, and the Russian Army crossed the Danube and advanced towards Constantinople. The war continued until March, 1878, when a treaty of peace between the two conflicting Powers was signed at San Stephano; then the other European countries intervened, and a Congress was assembled at Berlin in June, to settle the boundaries of the different states in the Balkan Peninsula.

Lord Beaconsfield and Lord Salisbury were sent as the British representatives to the Congress, and General Sir Lintorn Simmons and Capt. Ardagh accompanied them as technical advisers. The knowledge which the latter had gained during the time that he had previously spent in the Balkan States proved of the greatest value, and much of the work in connection with the settlement of the boundaries fell to his share; on his return to London he was recommended by Lord Beaconsfield for the civil C.B., an unusual distinction for so young an officer. But his work in the Balkan States was by no means at an end, as in September, 1878, he was selected as assistant to Colonel Home, R.E., who had been appointed British representative on the International Commission for delimiting the boundaries of Bulgaria.

Ardagh's journals, many extracts from which have been included in the Memoir by Lady Malmesbury, give a most interesting account of the difficulties met with by the Commission in the prosecution of their task. Poor Home was attacked by typhoid fever, brought on by exposure and hard work, and returned to England to die; and when the Commission re-assembled in the spring of 1879 he was succeeded as British Commissioner by Sir Edward Hamley. Great difficulties were raised by the Bulgarians and Russians, and the former actually fired at Ardagh and his party when engaged on survey work; it was not until September that the work was completed and the convention describing the boundary signed at Constantinople.

In June, 1880, an International Conference was assembled at Berlin to consider the question of the Turko-Greek frontier, and once more Sir Lintorn Simmons and Ardagh (who had been given a brevet majority for his work in Bulgaria) were ordered to attend as the British military advisers. The negociations were continued at Constantinople in the following year, and a Commission was then appointed, on which Ardagh

Digitized by Google

was the senior British representative, for the actual marking out of the boundary, and on his shoulders fell the brunt of the work. Lord Dufferin, in his report to the Foreign Office, spoke enthusiastically of the manner in which he had fulfilled his duties.

In February, 1882, Ardagh was appointed Instructor in Military History at Chatham, but only held the appointment for a few months, as in the following July he was ordered to proceed to Egypt, and was one of the first of the British expeditionary force to land at Alexandria, a few days after the bombardment. As at that time only a small force had arrived, and as an attack by the Egyptian troops under Arabi was possible, steps had at once to be taken for putting the place in a state of defence, and the duty of so doing was entrusted to Ardagh, who was ably assisted by Capt. E. Wood and other Engineer officers. He was summoned by Lord Wolseley to Ismailieh at the end of August, and was present at the Battle of Tel-el-Kebir. A very good reproduction of his panoramic sketch of the battle is included in the Memoir, which shows in a graphic manner the position of the British troops at the time when the Highland Brigade and the brigade commanded by Sir Gerald Graham were approaching the Egyptian works. As Ardagh remained at Tel-el-Kebir for a week after the fight, he had the opportunity of making himself thoroughly acquainted with the position, and took much pains to make his sketch an accurate record of what had happened.

After the conclusion of the campaign Ardagh was appointed D.A.A.G. on the Staff of General Sir A. Alison, who was placed in command of the British Army of Occupation in Egypt, and was present during the severe cholera epidemic in 1883. His next experience of active service was in February, 1884, when Sir G. Graham was sent in command of a British force to Suakin, and Ardagh was attached to his Staff as Commanding Royal Engineer and Chief of the Intelligence Department. Lady Malmesbury has given some interesting extracts from his diary descriptive of the campaign, and a sketch by him, showing the disposition of the troops at the Battle of Tamai just after the left-hand square, to which he was attached, was broken by the Arabs and re-formed with some difficulty. The defeat of the Dervishes at Tamai was followed by an advance along the Suakin-Berber road to Tambuk, when Graham might have gone on to the assistance of Gordon had he not been recalled by the British Government. Ardagh, who studied the question with his usual attention, was always in favour of the Suakin-Berber, as opposed to the Nile route, for operations in the Sudan. For his services in the Suakin Campaign he was given the military C.B., so that he was thus in the unusual position of wearing both the military and civil decoration.

In August, 1884, it was decided to send an expedition up the Nile, under the command of Lord Wolseley, for the relief of Khartoum, and Ardagh naturally hoped to have accompanied it; but he was ordered to remain in Cairo, and was appointed Commandant of the Base, a position which gave him an enormous amount of work—work that he carried out in an admirable way, as will be remembered by those who were serving with him in Cairo at the time.

Digitized by Google

But after the fall of Khartoum and the withdrawal of the Nile expeditionary force, when the Dervishes advanced into the province of Dongola, he had his chance, as he accompanied General Sir L. Stephenson as Senior Staff Officer with the force which was sent to drive back the Dervishes, and took a leading part in the short but brilliant campaign which ended with the Battle of Ginnis, when the Arabs were completely defeated. Ardagh was strongly in favour of going on to Dongola, but orders came from London to retreat, and the operations were naturally reported at Khartoum as a victory for the Dervishes.

After the conclusion of the Nile Campaign, Ardagh was employed on the question of the adjustment of the Anglo-Egyptian finances, a very complicated matter, which engaged his attention until the beginning of 1887, when he returned to the War Office to fulfil the duties of A.A.G. for Mobilization at the Intelligence Department, a post which he held until October, 1888, when the Marquess of Lansdowne, who had been appointed Viceroy, asked him to accompany him to India as Private Secretary. He held the appointment during the whole period that Lord Lansdowne was Viceroy, and remaining for a short time with the Earl of Elgin, his successor, returned to England in 1894.

Ardagh was next appointed Commandant of the School of Military Engineering at Chatham, and was then selected for the important post of Director of Military Intelligence at the War Office in succession to Sir E. Chapman.

While he was in charge of the office the war in South Africa broke out, and considerable blame was given him at the time, on the ground that he had not kept the Commander-in-Chief and the Government fully informed as to the strength of the Boer forces. But the evidence given before the Commission on the South African War showed how absolutely unjustifiable was the attack on Ardagh, and that he had done everything that was required in obtaining and supplying the Government with all the required information. This part of the Memoir is very interesting and deserves careful perusal.

Ardagh's later services at the Hague Conference, on the South African Deportation and Compensation Commissions, the Chili-Argentine Boundary Commission, the Suez Canal Commission, and the meeting of the Red Cross Convention at Geneva are all fully treated.

Ardagh was fortunate in having had a most interesting and active career, and the thorough manner in which he carried out the very varied duties committed to his charge gives an example that may well be followed by other Royal Engineer officers.

The work is admirably illustrated with a selection of his own sketches, and there is a good map to explain his work in the Balkan Peninsula. In conclusion, we would like to congratulate Lady Malmesbury on the able manner in which she has completed her difficult task, and would recommend the handsome volume to all the officers of the Corps.

Digitized by Google

## THE HISTORICAL RECORDS OF THE FIFTH (ROYAL IRISH) LANCERS.

*By* MAJOR W. T. WILLCOX, 3RD HUSSARS, LATE CAPTAIN, 5TH LANCERS.—(London: Arthur Doubleday & Co., Ltd., 1908. 42s.).

Much has been done in recent years towards the development of *esprit de corps* both by means of regimental monthly and annual publications and by regimental histories. The *Rifle Brigade Chronicle* probably represents the high-water mark hitherto attained by an annual regimental publication, and the history under review is probably the most elaborate and best got-up general record of any regiment or corps in the Army.

Capt. Willcox served for 13 years in the 5th Lancers, and was then promoted to a majority in the 3rd Hussars. During the last three years of his service in the former regiment he occupied himself in collecting its historical records. It is not too much to say that he has raised the standard of regimental histories to a point higher than any reached hitherto.

The letterpress, plates, and maps are alike excellent, the appendices containing biographies of distinguished officers of the regiment, and an alphabetical list of officers of the regiment from the date of its first formation as Wynne's Inniskilling Dragoons, in 1689, to the present day. The history embraces the campaigns in Flanders under the Duke of Marlborough, the Irish Rebellion of 1798, the Nile Expedition of 1885, and the South African War, 1899 to 1902.

One of the most striking figures in the history of the regiment is that of Colonel J. J. Scott Chisholme—popularly known as "Jabber" Chisholme—whose portrait is given opposite p. 208.

His five years' tenure of the command of the regiment expired on the 12th August, 1899, and exactly two months afterwards the following extract from Ladysmith garrison orders was published as a Regimental Order in the 5th Lancers:—

> "WAR.
> The Secretary of State for War telegraphs from London that war has been declared by the South African Republic, and the British Agent at Pretoria has been instructed to ask for his credentials and withdraw to British territory."

Meanwhile Scott Chisholme had been engaged in organizing a local mounted corps, known as the Imperial Light Horse.

On the 21st October he led his newly-raised regiment into action at Elandslaagte, and had the satisfaction of knowing that "his boys were doing well" before his brilliant career was ended by a bullet in the brain.

The author comments as follows:—"'Killed in action'—a soldier's death, as he himself used to say; but surely no officer was ever more sincerely mourned on the battlefield by his men than was 'Jabber' by those who had served him so well in India and South Africa. And the hard luck of it all was that fate had decreed he was not to lead the men

Digitized by Google

he had trained so well into their first fight, but at the last moment, and on the eve of war, had severed his connection with the regiment."

The book is a new illustration of the Hesiodic maxim that in military history, as in so many other subjects, "the half is more than the whole." By eliminating as far as possible all the history of the war except in so far as the 5th Lancers were concerned, the interest to members of the regiment is increased fourfold. Many a man who would never study a general military history unless he were obliged to would eagerly devour the smallest details referring to his own regiment.

In a Corps like the Royal Engineers this surely points to the desirability of keeping up company histories and developing company *esprit de corps*. Its unit is the company, and many who would eagerly read a company history would hesitate before tackling a general account of the doings of the Corps in a long-drawn-out campaign such as that fought in South Africa from 1899 to 1902.

B. R. WARD.

## SANITARY ENGINEERING.

*By* MOORE & SILCOCK.—(Published by B. T. Batsford, London. 2 vols. £2 2s.).

Eight years ago a notice of Colonel E. C. S. Moore's colossal work on Sanitary Engineering appeared in these columns, and it was then stated that a book of reference had been produced which could fairly claim to be the standard work in this branch of engineering science. The talented author, who was one of the first to investigate and to recognize the possibilities of the new methods of purification of that day, spared no pains to bring within the compass of one volume the most recent results of the remarkable development in that particular direction which characterized the close of the last century, and the book was received by engineers as a most valuable compendium of all that was ascertainable on the subject. Shortly after its publication Colonel Moore was called to his rest, his loss being deeply felt not only by a large circle of his personal friends, but by a still wider circle, to whom he was known by his writings.

During the intervening years great strides have been made in the further development of those methods of bacterial purification which were introduced in the nineties, and—the second edition of the book being exhausted—the eminent authority on all matters of sanitary engineering, Mr. E. J. Silcock, M. INST. C.E., F.S.I., F.G.S., was asked to bring out a third edition, and this has now been published.

In this he has preserved all the features which made the original work so valuable, wisely omitting that which the march of time had rendered obsolete, and he has brought thoroughly up to date the information concerning the most successful solutions, which experience has approved, of the problems which confront the engineer.

Digitized by Google

Principles are discussed and practical methods are described illustrating the success which has attended the combined efforts of the chemist and the engineer, with a wealth of detail which cannot fail to be of the greatest assistance to all those who may be called upon to grapple with problems similar to those which are so lucidly explained. The most recent Reports of the Royal Commission are dealt with and the gist of them recorded, and side by side with these the requirements of the Local Government Board (revised up to this present year) are detailed and discussed.

The publishers have wisely divided the 900 pages and over 90 most beautifully produced plates, into two volumes, as otherwise the work would have been too cumbersome to handle conveniently, and they are to be congratulated on the style, combining clear type with excellent paper, in which they have published the valuable materials of the author.

Speaking broadly, the first volume deals with the details of Construction, and the second with the principles and practice of Sanitation, and reference is facilitated by a well-arranged and comprehensive index.

J. WINN.

## PRACTICAL ARABIC GRAMMAR.

The Clarendon Press has recently published the fourth edition of Part II. of Green's *Practical Arabic Grammar*, to supplement the fourth edition of Part I., which was published apparently in 1901.

The grammar generally follows the lines of the earlier editions, but has been both enlarged and thoroughly revised, and in the Preface to Part I. Colonel Green points out that, at the request of the delegates of the Oxford University Press, he has entirely recast the system of transliteration previously made use of. This is in order to bring the work into conformity with the system adopted by the Geneva Congress of Orientalists in 1894.

Another improvement is that colloquial Arabic only is used in the body of the book, although the various grammatical inflexions and diacritical marks are given in the Syntax and Tables as an exercise in classical Arabic.

Finally a transliteration of many of the Arabic and reading exercises has been given, so as to enable the beginner to master the pronunciation and to help him with the reading of Arabic writing, and a few extracts from newspapers and manuscript letters are added for the more advanced students.

Part II. has also been revised so as to conform to the system of transliteration adopted now in Part I.

Digitized by Google

# *NOTICES OF MAGAZINES.*

## Journal des Sciences Militaires.

*April 1st*, 1909.

The instalment of "Instruction of an Infantry Regiment" in this number considers the decisive attack. Everybody agrees as to the necessity for such a manœuvre, but there is considerable difference of opinion as to the way in which it should be carried out. Some authorities consider that the commander should be able to reconnoitre and pick out the weak point of the enemy's position and attack it, whether it is the front or the flank. Others think that frontal attacks are so dangerous that wide turning movements should be made instead. A flank attack is of the nature of a surprise, and is consequently more effective.

The Russo-Japanese War has shown that a frontal attack may succeed in spite of all its difficulties; but its results can never be anything but small, even in the most favourable cases. As modern civilization renders it imperative to cut down a campaign to the shortest possible time, frontal attacks giving small results are not sound measures. We must remember that what has been done once, with one armament and army, is not necessarily possible again with other armaments and armies.

According to General Langlois, Skobeleff's attacks on Plevna did not advance more than 1 kilomètre an hour; at Liao-Yang the final Japanese advance covered 900 mètres in an hour and ten minutes. The present tendency is for the distance covered by the final rush to grow shorter and shorter. In the French Regulations the initiative in making this rush is taken by the commander of the attack; but Germans and Japanese consider that the firing line may, in some circumstances, take this decision into its own hands.

The German cavalry is about to receive a bayonet for use when fighting dismounted, and an article in this number suggests fitting a bayonet to the French cavalry carbine in such a way that, when not in use, it may be folded back into a groove in the woodwork. Opinions are divided in France as regards the *rôle* of cavalry. Some are in favour of the cavalry doing most of its fighting on foot; the others declare that by doing so they will throw away their great moral advantage, viz., speed of movement. Some again declare it impossible for the French two-year men to face the German three and four-year men if on horseback. Others reply that it will be impossible to check by fire alone the German cavalry, which is trained to attack hostile cavalry at sight. The conclusion drawn is that, since in peace it is impossible to prove the superiority or otherwise of shock over fire action, the cavalry must be trained in both. Consequently, as it may have to fight on foot, it should be better armed for that purpose.

Digitized by Google

At present a dismounted cavalryman has nothing but his carbine. A bayonet of some sort is essential. It should be very light, so as not to alter the ballistics of the carbine; it should be adaptable to the present carbine, and if possible it should be permanently attached to it, since it gets in the way if worn in a scabbard attached to the waistbelt. In addition, the weapon should be of such a nature that the cavalry will never forget or distrust mounted action from too great love of dismounted action, and so become mere mounted infantry.

H. L. WOODHOUSE.

## LE BULLETIN.

*February 15th*, 1909.

GERMAN FIELD SERVICE REGULATIONS.—This number treats of the use of outposts in siege warfare, and shows the influence of the late war in the East. The strength of siege outposts is placed at a high figure, one-third of the infantry allotted to each sector. Under the head of "Marches" it is noted that the passing of troops over military bridges should be under the control of the engineers.

THE MODERN MILITARY INSTRUCTOR.—*Marceau.*—The subject is continued. The author gives various hints to aid the company officer in forming an opinion on the merits of his men, and advises that a notebook should be kept to record against each man's name any points which come to his notice, as giving an indication of character. Stress is laid on the importance of eliminating any instruction which is not preparation for war.

ATTACK AND DEFENCE OF FIELD FORTIFICATIONS.—The value of villages, farms, and woods in a defensive position is discussed, that of the latter depending on the nature of the trees—large trees being better than saplings and undergrowth. Protection from fire in woods and villages is usually obtained 50—100 yards from the front edge. The quantity of ammunition needed to cause much damage, generally precludes an attempt being made to drive out by shell-fire, troops sheltered in them. For troops occupying woods, while the front edge is only held weakly, internal defence must be strongly organized. The author lays down that woods should always be occupied, when they exist in the defensive line, unless no field of fire is obtainable, in which case a position in advance of them must be taken up.

In dealing with advanced posts, the author is careful to distinguish between them and the outpost positions, the object of the latter being attained as soon as the troops in the main position are ready to repel an attack. The former should, on the other hand, never be abandoned before attack, and must be so chosen as to permit both of a flanking fire from the main position, and also of artillery support. The garrison of advanced posts should not usually exceed two infantry companies, and defensive works should be made with open gorges, so that they cannot be utilized by the enemy when captured. Considering the best means of

Digitized by Google

counter-attack, the author comes to the conclusion that it can only be successfully delivered from a flank, unless the enemy is completely shaken, or unless it is absolutely necessary to dislodge him from a foothold close to the defensive line.

*February 28th*, 1909.

Attack and Defence of Field Fortifications.—Continuing the subject of the counter-attack, it is suggested that it should generally be delivered as soon as the enemy has deployed his reserves and committed himself to a frontal attack.

In a frontal attack on a fortified position, the preparatory deployment would take place at 2 to 3 miles from the position, but up to the moment of assault, reserves in close order must be available. When the advance troops arrive within 300 yards they must make a careful reconnaissance of the favourable points of attack; this will be carried out by officers' patrols of engineers and infantry, aided possibly in the future by dirigibles.

The formation of assaulting columns depends on the number and size of the breaches in obstacles. They are usually preceded by pioneers. For the assault, a preparatory deployment under cover is necessary, and this would usually be made by night. The sharpshooters of each company take up a position to cover deployment, and the remaining troops are formed into assaulting columns. The latter advance in close order and in silence behind the pioneers and sharpshooters. When the sharpshooters reach the obstacles, or at any rate when 50 yards from the enemy's line, they throw themselves down and open fire on the enemy to distract their attention from the assaulting columns. The latter cross the line of obstacles, deploy, and rush the trenches. The most favourable moment for an assault is at daybreak, as the night affords time to make preparations.

Foreign Military Intelligence.—The French infantry are to be trained in the use of hand grenades. The present grenade is a hollow cast-iron shell, 3″ diameter, weighing 2 lbs. empty, 2½ lbs. full. It contains a powder charge, and a quickmatch which lights a slow combustion composition, which burns for 5 seconds. The grenade is thrown by hand and the quickmatch lighted by means of a friction tube, the igniter of which is pulled by a hook attached to a leather wristlet worn by the man. The distance to which it can be thrown is 20 yards.

*March 15th*, 1909.

Contains nothing of special interest.

'E.R.'

---

## Militärische Presse.

*May*, 1909.

In the *Militärische Presse* of the 16th January, an article appears out of the *Artilleristisches Blatt*, of which the following is a *précis*:—

Illumination of Foreground by Electric Light.—Every modern army has Search-light Sections now included in its organization. As a

Digitized by Google

rule, in the past their use has been limited to siege warfare or coast defence. They have without doubt their uses too in field operations, but, because they are unknown to the majority of the field army, they are seldom included in night operations. Every military student knows what an important *rôle* they played in the Russo-Japanese War, especially during the Siege of Port Arthur, and it behoves all modern leaders of to-day to employ every aid, however technical, to bring his operations to a successful termination. Attention is drawn to a publication by an artillery captain, commander of a search-light detachment in Pola, Austria. This pamphlet has especially been written as an aid and guide for officers of all arms.

Each S.L. detachment is similar in its organization to an infantry company, and is divided into "Züge":—

(1). The observation group.
(2). The projector group.
(3). The engine group.
(4). A reserve group.
(5). A telephone group.

The whole "service" is under (1). The details of the projector and lamp are then described. The 35-cm. size is fitted with "legs"; the 90-cm. size, as a rule, is carried in a 4-wheeled wagon. The 150-cm. size is used for coast work only. The reflector is a speciality of the Siemens Schukert Werke, made of glass and paraboloid in form. The projector body is closed by a plain glass door or fitted with a double dispersing lens. This latter however absorbs a very great quantity of light. The accessories are the controller and the dousing arrangement. As regards the control, when using motors the observer himself moves the projector, but with hand traversing all movements must be done by the man at the projector. Signalling by means of the dark shutter is referred to. The range of the light depends on the intensity of the beam and the state of the atmosphere and is very variable, but roughly we may say that for the 35-cm. size, it is 1,000 mètres, for 90-cm., up to 3,000 mètres, and for 150-cm., up to 5,000 mètres.

Direct current dynamos are used for supplying the current, the 35-cm. being sometimes run off accumulators. The dynamo is run by a steam or benzine engine. The latter must be used where portable sets are required. The reserve group supplies the relief numbers, and is in charge of all stores and repair materials. The horse teams are attached to this group when the lights have been started up.

The instructions point out that to get the best use out of the S.L.'s, the S.L. officer should be given a free hand by the higher C.O.'s, in the same way that battery C.O.'s carry out all their own preparations. The article finishes by urging that S.L.'s should be taken out on all big manœuvres, so that all arms and higher commanders should get to know something of their uses and possibilities in all night operations.

R. WALKER.

Digitized by Google

## Revue du Génie Militaire.

### *January*, 1909.

The Campaigns in China, 1858—1862.—This is an extract from the diary of the late General Gallimard, who served in Tonkin and North China as a captain of engineers. It is an account of the writer's personal experiences rather than a history of the operations.

The Fourth Arm in Conjunction with the Others.—An appreciation of a previous article on the same subject. The writer's remarks are chiefly quotations from military books and essays. They shed no new light on the subject.

### *February*, 1909.

The Defence of Bou-Denib.—The Moors were defeated by the French in May, 1908, near the small town of Bou-Denib. The French then held this point as an advanced post. The town is walled, but it stands in a valley and is surrounded by palm trees, and is not therefore suitable for defence. The French constructed a line of works across the valley. The principal work was a redoubt for a garrison of 1,500 men, situated on a hill to the north-west of the town. On the opposite side of the valley a blockhouse for 60 men was constructed. A Moorish town in the centre of the valley was also held as a connecting point between the other two works.

The defences of the works consisted of loopholed mud walls 2′ thick. These were quite bullet-proof. The walls were built partly with puddled clay rammed into a mould, and partly with sundried bricks. The town itself was defended by occupying houses that overlooked the two gates, and a few flanking towers on the wall.

The Moors attacked the position on the 1st September, and were repulsed with heavy loss.

The Engineers in China.—An account of the organization and distribution of the French Engineers in North China from 1901 to 1906.

Military Kites.—An account of the apparatus used in the Russian Navy and the British Army. The Russians employ a team of six or seven box kites. The car is fixed to the cable just below the lowest kite. The apparatus oscillates a good deal while the cable is being paid out. Apparently the British system is more efficient.

### *March*, 1909.

The Engineers in China.—The continuation of an article commenced in the February number.

Military Kites.—A continuation of a previous article. The author discusses the theoretical part of the subject. Calculations for determining the centre of pressure and angle of equilibrium are given.

J. E. E. Craster.

Digitized by Google

## *CORRESPONDENCE.*

### RAILWAY SIGNALLING.

SIR,

In the March number of the *R.E. Journal*, Capt. A. Gardiner criticized our article on the electro-pneumatic signalling installation on the low-pressure air system adopted by the London and South Western Railway, and we should therefore like to add a few remarks in reply.

With regard to the general article, we intended it only as a description of what we actually found on the London and South Western Railway, and not as the latest verdict. The installation has been in operation for some considerable time, has been extended in the course of the last few years from the experimental portion between Andover and Greatley to the parts of the line enumerated in our article, and is at present being laid down for use on the most important portion of the line near London.

We will deal with the objections raised by Capt. Gardiner in the order he has taken them.

*Switch and Lock Movement.*—There is no electric check in use, and it has been found that the pneumatic indication is sufficient. As all parts of the operating mechanism are made of steel, it is unlikely that both the switch rod and the lock rod would be disconnected from the motion plate at the same time either by accident or by neglect. In case of any "trailing through," the motion plate itself or some of the other connections would be bent, twisted, or otherwise disarranged, but not absolutely disconnected, thus preventing a complete movement of the motion plate, and this would consequently indicate to the signalman that something was wrong. If *Figs.* 5 and 6 of the article are studied, it will be seen that to trail through any points on the main line the engine driver would have to pass two signals at danger, in addition to the warning of the preceding distant signal.

*Replacement of Signals by Air Pressure.*—In all systems of railway signalling some method has to be adopted to place the signals at danger, and this replacement by air pressure seems very satisfactory when it is considered that the *total* air pressure on the piston tending to replace the signal at danger is 286 lbs. The magnitude of this seems to have been overlooked. All signals are replaced to danger on the *failure* of motive power by gravity, thus ensuring an additional safety precaution, in exactly the same way as a signal returns to danger by the action of gravity on the failure of a current on the "all electric." In ordinary working the cessation of pressure below the piston acts

Digitized by Google

simultaneously with the application of pressure on the top of the piston, and this makes the return to the danger position positive and rapid. The replacement of signals to danger is also clearly indicated to the signalman by the completion of the movement of the lever in his box.

*Electric Signal "Replacement."* — The time taken for the cycle of operations is about one second, with the advantage that the signalman is certain that his signal has been replaced to danger by the return of his lever. In addition, this replacement is used as a lock on the signal lever, which cannot be pulled off for the signal to be again lowered while a train is in the section in advance.

With regard to the criticism of the characteristics of this system :—

(1). It is hard to regard the first item as anything but a quibble. When we mention "all electric" systems, we do not go into the means of generating and otherwise obtaining an electric current, and we can hardly agree that air-compressing machinery is not less complicated than a dynamo, as it runs at a much slower speed, and is far more easily adaptable to its varying load.

(2). The distributing mains require practically no attention, and have to be maintained at that pressure, so as to always have a sufficient supply of air to supply the operating pipes.

(3). The extra precaution of being independent of gravity for ordinary operations, and of having that force in reserve in case of failure, does not require any further remarks.

(4), (5), and (6). The whole purport of these objections seems to be an idea that the operating of a signal or points takes a considerable time. As we have pointed out above, the whole time occupied is at the most a second, and is in fact no longer than the switch and motor operating the points at the electric signal box at Derby.

*Advantages over the "All Electric."*—The great advantage of a weak electric current is that the percentage of leakage is less, and, in addition to this, the battery power to generate it is simple. All the electric cells for the relay and cut-out valves are of the same pattern as those for track circuits, and can be recharged when run down, by an individual of ordinary intelligence. They do not require a skilled electrician to look after them, and it has not been found necessary to use the 50 per cent., or in fact any increase of air pressure, for five or six years on the London and South Western Railway.

The greatest drawback to an "all electric" system on one of the main trunk lines seems to be the means of obtaining the electric power required. Either one must provide generating plant accumulators, etc., at each signal box, with large primary cost and a large staff to maintain and attend to them, or, failing this, generating plant at certain centres to supply the power, and this entails large cost of distributing it to the signal boxes.

With regard to primary cost, the installation on the London and South Western Railway seems to be the only section of line of considerable length on any of the out-of-London railways to give reliable data, and a comparison of primary cost and also maintenance charges would be misleading. The greatest argument in favour of this system seems to be

Digitized by Google

that it is being extended, while the "all electric," which is being taken up by the Midland Railway, is not proving a saving, and is only being installed to work experimentally a set of automatic signals between Keighley and Steeton. We are informed that it is costing more than a mechanical box, including the capital value of the signalman's wages who would be required to work it.

Finally, "fineness of detection" seems rather out of place on a railway track, and as the lock rods are adjusted to within $\frac{1}{50}$ of an inch for each position of a switch, this seems to be fine enough for all practical purposes.

G. C. V. FENTON,
*Lieut., R.E.*
W. G. TYRRELL,
*Lieut., R.E.*

The Editor, *R.E. Journal.*

Digitized by Google

SPECIFY

# INDENTED STEEL BARS

FOR YOUR

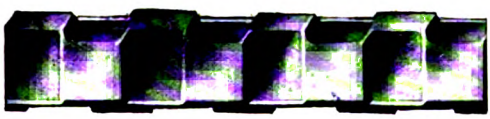
## *Reinforced Concrete Work,*

And you will obtain HIGHEST POSSIBLE STANDARD OF EFFICIENCY, combined with GREATEST POSSIBLE ECONOMY.

**NO ROYALTIES TO PAY.**

Head Office :—

**QUEEN ANNE'S CHAMBERS, LONDON, S.W.**



Branches all over the United Kingdom.

TELEGRAMS :—"PATINBAR, LONDON."

# RUBEROID !
# ROOFING !

A High Grade Permanent Roofing Material in general use for all classes of Building. Its light weight as compared with other roof coverings makes it particularly useful where long transport of building materials is necessary.

**THOROUGHLY TESTED FOR ALL CLIMATES.**

Supplied to H.M. WAR OFFICE for

**GIBRALTAR, SIERRA LEONE, CHATHAM, MAIDSTONE, PORTSMOUTH, BANTRY BAY, Etc.**

Orderly Room, Infantry Lines, Quetta, Beloochistan.

Unaffected by Concussion of Gun Fire.

—:o:—

**CAN BE LAID on all kinds of ROOFS, FLAT OR PITCH, CONCRETE OR WOOD.**

Full particulars of cost and shipping weights gladly supplied. Our Illustrated Catalogue, No. 39, and samples sent post free on application.

**THE RUBEROID COMPANY, Limited, 81 & 83, Knightrider St., LONDON, E.C.**

Digitized by Google

# THE HELLIWELL
# PATENT "PERFECTION" GLAZING.

**ADVANTAGES.**

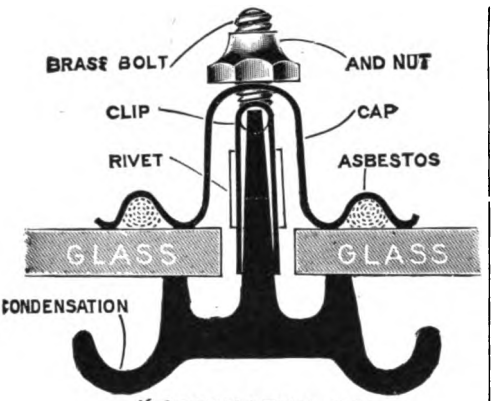
No Putty.
No Paint.

Guaranteed Water-tight and Dust Proof.

Easily Repaired.

Planks laid in Safety across Caps.

Steel Bars galvanized; and also entirely covered with Lead to prevent Corrosion.




"ORDINARY" BAR.
"Ordinary" Section.
BARS of different strengths, to carry up to 12ft. without Purlin.
CAPS in either Copper, Zinc, or Lead.

**EXTENSIVELY USED BY**

H.M. Government, for Barracks, Dock Sheds, Post Offices, Stores, etc.

All the leading Railway Companies.

Municipal Authorities, for Markets, Baths, Libraries, Art Galleries, Schools, etc.

Also for every kind of Glass Roofing.

Head Office and Works: **HELLIWELL & CO., Ltd.,**
London Office: 11, Victoria Street, Westminster, S.W. **BRIGHOUSE, YORKS.**

# Royal United Service Institution,

**WHITEHALL, S.W.**

Contains the best professional Library in the United Kingdom; an excellent collection of Maps and Charts; Reading and Smoking Rooms provided with the leading papers, periodicals, and writing materials; a Museum of Naval and Military relics and trophies; and a Theatre in which lectures upon professional subjects, followed by discussions, are frequently given.

## TERMS OF MEMBERSHIP.

**ANNUAL MEMBERS, £1 1 0 on entrance, £1 1 0 annually.**
**LIFE MEMBERS - - - £15 0 0**

Officers whose names appear in the Official Navy and Army Lists become members on payment of the above fees, and applications for membership, giving rank, qualification, and address, should be made to the Secretary.

**"THE JOURNAL OF THE ROYAL UNITED SERVICE INSTITUTION."**

This valuable "Journal" is published monthly, and is sent post free to all Members of the Institution; it is also sent regularly each month to all Naval and Military Attachés, and the principal Foreign Embassies and Legations in London; it is also in the hands of and extensively read by Officers in nearly every Army in the World, as well as Officers of our Colonial Forces.

"The R.U.S.I. Journal" is the Official Organ of the above Institution; it contains the Lectures given in the Theatre, Articles on Professional Subjects, important Naval and Military Notes, also fullest particulars of Naval and Military Inventions, Notices of Books, etc.

The Circulation is more than double that of any Service Publication in existence; it has the largest circulation in India, the Colonies, and also on the Continent of any Service Publication published in the English language; it is widely read, and of great Official importance in most Foreign Countries.


Digitized by Google

# PROFESSIONAL PAPERS OF THE CORPS OF ROYAL ENGINEERS.

FOURTH SERIES.—VOL. I., 1905.

PAPER I. **Simple Tunnel Work on the Mari-Attock Railway, Panjab,** by Capt. H. E. C. Cowie, D.S.O., R.E. ..... 1s.

,, II. **Long Span Bridges,** by Max am Ende, M. INST. C.E. ..... 1s. 6d.

,, III. **Recent Works in the N.W. Frontier Province, India** (Fortified Posts, Roads, Bridges, Civil Buildings), by Bt.-Col. G. K. Scott-Moncrieff, C.I.E., R.E. ..... 3s. 6d.

,, IV. **Armoured Trains,** by Capt. H. O. Mance, D.S.O., R.E. ..... 3s. 6d.

,, V. **Reinforced Concrete,** by Lt.-Col. J. Winn, late R.E. ..... 2s. 6d.

,, VI. **Fortress Warfare,** by Capt. Moritz Ritter von Brunner. 9th edition of the work originally written by Field Marshal von Brunner. Translated by Capt. C. Otley Place, D.S.O., R.E. ..... 3s 6d.

,, VII. **Fortresses and Military Engineering in Recent Literature.** No. 43 of the "Mitteilungen des Ingenieur-Komitees." Translated by Capt. F. A. Buzzard, R.F.A. ..... 5s.

VOL. II., 1908.

PAPER I. **The Theory of Arched Masonry Dams,** by Capt. A. ff. Garrett, R.E. ..... 1s. 6d.

,, II. **Report on Mechanical Road Transport for India,** by Capt. E. N. Manley, R.E. ..... 2s.

,, III. **The Khushalgarh Bridge,** by Capt. H. E. C. Cowie, D.S.O., R.E. ..... 2s. 6d.

The price of separate Papers as above, in paper wrappers, is net.

They may be obtained from Messrs. W. & J. MACKAY & Co., LTD., Chatham, or from any Bookseller.

Digitized by Google

## "ANCHOR" LINE.

## Passenger and Cargo Services.

LIVERPOOL to BOMBAY & KARACHI (*vid* Bombay). Fortnightly.

LIVERPOOL to CALCUTTA. Fortnightly.
**All Vessels call at Egyptian Ports.**

Large New Steamers. Splendid Accommodation for Passengers. Electric Light and Fans.
Excellent Cuisine. Every Comfort.
Moderate Fares, both Single and Return

Apply—"ANCHOR" LINE (Henderson Brothers), Ltd., Liverpool, London, Glasgow, &c.

## Nippon Yusen Kaisha.

Japan direct from London in 47 days, calling at COLOMBO, SINGAPORE and HONG KONG, by fast steamers fortnightly.

| | |
|---|---|
| INABU MARU ... ... | June 12. |
| *ATSUTA MARU .. ... | ,, 19. |
| HITACHI MARU .. | ,, 26. |

* This new steamer calls at Marseilles.

**To Japan, £54, 1st Class; £37 10s., 2nd Class; to other Ports at equally moderate rates.**

ROUND THE WORLD, £107

**For Fares, etc., apply at—**

**4, LLOYD'S AVENUE, LONDON, E.C.**

## Institution SILLIG,

**BELLERIVE, VEVEY, SWITZERLAND.**

**ESTABLISHED IN 1836.**

A HIGH-CLASS SCHOOL for the education of Boys in Classical, Scientific, Military, and Commercial Subjects, and for General, Moral, Mental, and Physical Development.

PRINCIPAL:

**MAX SILLIG—DE VALLIÈRE.**

## THE ARMY SCHOOL,

**Near MAIDENHEAD**

(Approved by the Army Council).

**Head Master:**

E. G. A. Beckwith, M.A. Oxon.

*(Late Exhibitioner of Winchester and Magdalen College).*

"A small public school in which boys from the age of twelve are prepared for the Army. The school buildings include a chapel, large dining hall, swimming bath, gymnasium, chemical and physical laboratories, besides 30 acres of playing ground."

SUCCESSES, 1907—1908.
Woolwich—One.
Sandhurst—Thirteen.
Qualifying Certificates—Sixteen.
Leaving Certificate—Five (Three Woolwich).

For FEES, etc. (reduced for Sons of Officers), apply to the Head Master.

## NAVIGAZIONE GENERALE ITALIANA.

The fine steamers "R. RUBATTINO" and "D. BALDUINO" sail alternately from GENOA TO BOMBAY on the 18th of each month, at 2 a.m.

FARES: 1st Class, £40 & £33; 2nd Class, £27 10s.; 3rd Class, £11.

GENOA TO ALEXANDRIA every Saturday, at 9 p.m.

NAPLES TO PALERMO every Evening, at 7.45 p.m.

For Tickets and Berths apply to the Co.'s Agents—

**ALFRED LAMING & CO., 8, Leadenhall Street, E.C.**

## NOTES FOR THE TACTICAL FITNESS EXAMINATION,

With Sample Schemes and Solutions,

By Major A. T. MOORE, R.E.

PRICE
TWO SHILLINGS AND SIXPENCE,
Post 3d. Extra.

Obtainable from the Secretary, R.E. Institute, Chatham, and Rees, Limited, 119, Pall Mall, S.W.

## G. E. CARRINGTON,

For many years Master Tailor, Royal Engineers,

## *TAILOR & MILITARY OUTFITTER,*

53, HIGH STREET,
OLD BROMPTON, KENT,

Attends CARLTON HOUSE, REGENT STREET, near Waterloo Place, S.W., every TUESDAY and THURSDAY, from 11 a.m. to 6 p.m., and at any other time by appointment.


Digitized by Google

# R.E. INSTITUTE

# New Publications.

---

MANUAL OF

## Road Construction & Maintenance

**Compiled at the S.M.E., by MAJOR PAUL, R.E.**

**FULLY ILLUSTRATED.**

Price **4s. 6d.**, Post Free. Members of the R.E. Institute, **3s.**

---

**ABBREVIATED NOTES**

**ON**

## Military Engineering

CONTENTS:

**Ropes, Spars, Tackles, Strength of Materials, Bridging, Field Defences, Camping Arrangements, Demolitions, Roads.**

**POCKET BOOK SIZE. INTERLEAVED.**

Price **6d.**, Post Free.

---

## Modern Sewage Disposal,

BY

**Capt. and Hon. Major G. B. WILLIAMS, R.E. (T.).**

Reprinted from the R.E. JOURNAL. Price **6d.**, Post Free.


Digitized by Google

The McKenzie, Holland, &
Westinghouse Power Signal Co., Ltd.

# POWER SIGNALLING

Electro-pneumatic,
all-electric, and
automatic signalling.

Address:

58, VICTORIA STREET, LONDON, S.W.

Telegrams: "POWERSIG, LONDON." Telephone: 890 Westminster.

PORTLAND CEMENT.

# CONCRETE FIRE-PROOF SLABS.

For Internal and External Walls.
As cheap as any other, with the following advantages:—

ECONOMY OF SPACE, GOOD KEY FOR PLASTER TILING, ETC., NO PLUGGING, AND SETTING COAT OF PLASTER ONLY REQUIRED.

*For Particulars and Prices apply to:*

THE ACTON CONCRETE PATENT PARTITION CO., 1909, Ltd.,
63, CORNHILL, LONDON, E.C.

Telegrams: "KONKREET, LONDON."
Telephone: 6294 AVENUE.

# THE OFFICE FOR OFFICERS.

**LIFE ASSURANCE.** Specially designed for the Services.
**CONVENIENTLY PAID FOR** by Bankers' Orders (Monthly Premiums if desired).
**NO MEDICAL EXAMINATION** up to £500, in ordinary circumstances.
**LOANS AND SURRENDER VALUES.** Liberal and easy conditions.
**EXCEPTIONALLY GOOD TERMS** for War Risks and Foreign Residence.

Call or write for new Service Prospectus.

Royal Exchange Assurance, (Incorporated 1720.)
West End Office: 44, PALL MALL, S.W.

1 3823-B/

Digitized by Google

# THE ROYAL ENGINEERS JOURNAL.

VOLUME IX.

JANUARY TO JUNE, 1909.

CHATHAM:
ROYAL ENGINEERS INSTITUTE.
AGENTS AND PRINTERS: W. & J. MACKAY & CO., LTD.

Digitized by Google

# VOLUME IX.


| | | |
|---|---|---|
| No. 1. | JANUARY... ... ... | Pages 1— 80 |
| ,, 2. | FEBRUARY ... ... | ,, 81—164 |
| ,, 3. | MARCH ... ... ... | ,, 165—244 |
| ,, 4. | APRIL ... ... ... | ,, 245—328 |
| ,, 5. | MAY ... ... ... | ,, 329—416 |
| ,, 6. | JUNE ... ... .. | ,, 417—496 |


Digitized by Google

# Subject Index.

*Original Articles are entered in thick type; Translations, Reviews, and Notices of Magazines in thin type.*


PAGE.

**ABYSSINIA, THE ITALIAN OPERATIONS IN, 1894 TO 1896,** by Capt. F. D. Irvine, R.E. ... ... ... ... ... ... 13

**AEROPLANES. A SHORT ACCOUNT OF SOME OF THE PRESENT-DAY AEROPLANES AND MOTORS FOR AERONAUTICAL PURPOSES,** by Lieuts. W. D. Beatty and A. D. de R. Martin, R.E. ... ... ... ... ... ... 245

An Appreciation of Austria-Hungary's Military Position. Translated from the *Neue Militärische Blätter* by Capt. E. G. Wace, R.E. ... 307

**BRIDGING MATERIAL, FURTHER EXPERIMENTS WITH PALM TREES AS,** by Bt. Major R. L. McClintock, D.S.O., R.E. ... 1

**CHALK, SWALLOW HOLES IN,** by Col. W. Pitt, late R.E. ... 365

Correspondence :—

A Mechanically Operated Flare, by Capt. W. G. S. Dobbie, R.E. ... 164

Railway Signalling, by Lieuts. G. C. V. Fenton and W. G. Tyrrell, R.E. ... 494

**ELECTRIC TRACTION ON RAILWAYS,** by Philip Dawson, Esq., M.Inst.C.E., M.I.Mech.E., M.I.E.E., Consulting Electrical Engineer to the L.B. & S.C.R. .. ... ... ... 329

Electrical Supply of Geneva. Translated from *Notes et croquis techniques sur Genève* by 2nd Lieut. A. H. Scott, R.E. ... ... ... 137

**EMPLOYMENT OF SAPPERS ON THE WORKS, NOTES ON,** by 'A Company Officer' ... ... ... ... ... ... 261

**FIELD COMPANIES, TERRITORIAL, ROYAL ENGINEERS,** by Major F. E. G. Skey, R.E. ... ... ... ... ... 23

**FIELD OPERATIONS, SEARCH LIGHTS IN,** by Capt. R. Walker ... 81

**FRENCH AND ENGLISH METHODS OF FIELD TELEGRAPHY,** by Major E. G. Godfrey-Faussett, R.E. ... ... ... 351

Field Kitchens in the German Army, by Col. E. Hartmann ... 377

**FIELD SUSPENSION BRIDGES, A GRAPHIC METHOD FOR CALCULATING,** by Capt. C. E. P. Sankey, R.E. ... ... 433


Digitized by Google

PAGE.

**GEOGRAPHICAL WORK, RECENT PROGRESS IN,** by Lt.-Col. C. F. Close, C.M.G., R.E. ... ... ... ... ... 169

**GRAPHIC METHOD FOR CALCULATING FIELD SUSPENSION BRIDGES,** by Capt. C. E. P. Sankey, R.E. ... ... ... 433

**HAND GRENADES, MANUFACTURE AND USE OF,** by Lieut. A. L. C. Neame, R.E. ... ... ... ... ... ... 165

**HEADQUARTER MESS, R.E.,** by Lt.-Col. B. R. Ward, R.E. ... 33, 129, 213, 297, 371, 455

**INSIDE AND OUTSIDE PORT ARTHUR,** by Col. J. F. Lewis, late R.E. 3

**ITALIAN OPERATIONS IN ABYSSINIA, 1894 TO 1896,** by Capt. F. D. Irvine, R.E. ... ... ... ... ... ... 13

**LIME AND CEMENT MIXTURES,** by Major A. H. D. Riach, R.E. ... 29

MAGAZINES, NOTICES OF :—

*Bollettino della Societa Aeronautica Italiana*, by 'J.E.C.' ... ... 315

*Bulletin*, by 'E.R.' ... ... ... ... ... 69, 323, 402, 490

*Internationale Revue über die Gesamten Armeen und Flotten*, by 'M' ... 316

*Journal of the Military Service Institution (U.S.A.)*, by Lieut. A. J. Swinton, R.E. ... ... ... ... ... ... 397

*Journal des Sciences Militaires*, by Lieut. H. L. Woodhouse, R.E. 144, 320, 394, 489

*Kriegstechnische Zeitschrift*, by 2nd Lieut. A. H. Scott, R.E. ... ... 70, 223

*Kriegstechnische Zeitung*, by 2nd Lieut. A. H. Scott, R.E. ... ... 401

*Militär Wochenblatt*, by 2nd Lieut. A. H. Scott, R.E. ... ... ... 404

*Militärische Presse*, by Capt. R. Walker, R.E. ... ... ... 491

*Militärische Presse*, by Capt. E. G. Wace, R.E. ... ... ... 72

*Nature*, by Maj.-Gen. W. E. Warrand, D.L., late R.E. ... ... 146, 406

*Neue Militärische Blätter*, by Capt. E. G. Wace, R.E. ... ... 74, 148, 224, 407

*Revue de l'Armee Belge*, by 2nd Lieut. A. H. Scott, R.E. ... ... 150

*Revue du Génie Militaire*, by Capt. J. E. E. Craster, R.E. ... 78, 153, 325, 493

*Revue Militaire des Armées Étrangères*, by 2nd Lieut. A. H. Scott, R.E. 79, 153, 326

*Revista de Engenheria Militar*, by 'M' ... ... ... ... 76

*Rivista di Artiglieria e Genio*, by Col. Sir E. T. Thackeray, V.C., K.C.B. 155, 227, 414

*Voënnyi Sbórnik*, by Capt. A. H. Bell, R.E. ... ... ... 160

**MAIN UNDERGROUND TELEGRAPH SYSTEM OF GREAT BRITAIN,** by Major W. A. J. O'Meara, C.M.G., late R.E. ... ... 191, 281

**MANUFACTURE AND USE OF HAND GRENADES,** by Lieut. A. L. C Neame, R.E. ... ... ... ... ... ... 165

**MODERN FORMS OF TRANSPORT, SOME POSSIBILITIES OF,** by Capt. R. Walker, R.E. ... ... ... ... ... 269

**MEMOIRS :—**

Lieut.-Gen. James Crofton, by Major W. Broadfoot, late R.E. 303

Col. John Roberts Hogg, R.E., by 'A.T.S.' ... ... 375

Lieut.-Gen. Sir Richard Hieram Sankey, K.C.B., by 'H.M.V.' 461

Major Percy Braybrook Molesworth, R.E., by Capt. P. Robinson-Embury, late R.E. ... ... ... 475

Digitized by Google

PAGE.

**MESS, THE HEADQUARTER, R.E.**, by Lt.-Col. B. R. Ward, R.E. ... ... ... ... 33, 129, 213, 297, 371, 455

MIRRORS WITH SEARCH-LIGHT PROJECTORS. Translated from the *Rivista Marittima* ... ... ... ... ... ... 389

**MODERN SEWAGE DISPOSAL**, by Capt. and Hon. Major G. B. Williams, R.E. (T.) ... ... ... ... ... 107

NEW FOOT SOLDIER. Translated from the *Matin* by 2nd Lieut. A. H. Scott, R.E. 41

**NOTES ON REINFORCED CONCRETE *v.* WOOD**, by Major A. H. D. Riach, R.E. ... ... ... ... ... ... 89

**PALM TREES AS BRIDGING MATERIAL, FURTHER EXPERIMENTS WITH**, by Bt. Major R. L. McClintock, D.S.O., R.E. ... 1

**PENETRATION OF A RIFLE BULLET INTO SNOW**, by Major J. C. Matheson, R.E. ... ... ... ... ... ... 349

**PORT ARTHUR, INSIDE AND OUTSIDE**, by Col. J. F. Lewis, late R.E. ... ... ... ... ... ... ... 3

**PORTLAND CEMENT, PROGRESS IN THE MANUFACTURE, TESTING, AND EMPLOYMENT OF**, by J. E. Baxter, Esq., F.C.S. ... 439

**PRESERVATION OF WINCHESTER CATHEDRAL**, by 2nd Lieut. J. M. Smeathman, R.E. ... ... ... ... ... 185

**PROPOSED TENSION BRIDGE**, by Capt. E. N. Mozley, R.E. ... 355

PROTECTION OF THE RAILWAY IN TRANS-AMUR. Translated from the *Voënnyi Sbórnik* by Capt. A. H. Bell, R.E. ... ... ... ... 141

RAILWAY SIGNALLING. ITS DEFECTS AND SUGGESTIONS FOR REMOVING THEM, by Capt. A. Gardiner, R.E. ... ... ... ... ... 49

**RAILWAY SIGNALLING**, by Capt. A. Gardiner, R.E. ... ... 181

**RAILWAYS, ELECTRIC TRACTION ON**, by P. Dawson, Esq., M.I.C.E., M.I.MECH.E., M.I.E.E., Consulting Electrical Engineer to the L.B. & S.C.R. ... ... ... ... ... ... 329

**RECENT PROGRESS IN GEOGRAPHICAL WORK**, by Lt.-Col. C. F. Close, C.M.G., R.E.... ... ... ... ... ... 169

RECENT PUBLICATIONS OF MILITARY INTEREST ... ... ... ... 231

**REINFORCED CONCRETE *v.* WOOD, NOTES ON**, by Major A. H. D. Riach, R.E. ... ... ... ... ... ... 89

REVIEWS :—

Practical Arabic Grammar ... ... ... .. ... 488

Recollections of a Life in the British Army, by Gen. Sir R. Harrison, G.C.B., C.M.G., late R.E. ... ... ... ... ... 219

Sanitary Engineering, by Moore & Silcock (Lt.-Col. J. Winn) ... ... 487

The Life of Major-Gen. Sir John Ardagh, by Susan, Countess of Malmesbury (Lady Ardagh) ... ... ... .. ... ... 481

The Historical Records of the Fifth (Royal Irish) Lancers, by Major W. T. Willcox, 3rd Hussars, late Capt., 5th Lancers (Lt.-Col. B. R. Ward) .. 486

Topographical Surveying and Sketching, by Major T. H. Rees, Corps of Engineers, U.S. Army ... ... ... ... ... 221

War Songs ... ... ... ... ... ... ... 222

Digitized by Google

PAGE.

**SAPPERS ON THE WORKS, NOTES ON THE EMPLOYMENT OF,** by 'A Company Officer' ... ... ... ... ... 261

**SEARCH LIGHTS IN FIELD OPERATIONS,** by Capt. R. Walker ... 81

**SEWAGE DISPOSAL, MODERN,** by Capt. and Hon. Major G. B. Williams, R.E. (T.) ... ... ... ... ... 107

**SIGNALLING, RAILWAY,** by Capt. A. Gardiner, R.E. ... ... 181

SKERRIES WIRELESS TELEPHONE, THE (from the *P.O. Electrical Engineers Journal*), by 2nd Lieut. A. H. Scott, R.E. ... ... ... ... 217

**SNOW, PENETRATION OF A RIFLE BULLET INTO,** by Major J. C. Matheson, R.E. ... ... ... ... ... 349

**SOME POSSIBILITIES OF MODERN FORMS OF TRANSPORT,** by Capt. R. Walker, R.E. ... ... ... ... ... 269

**STAFF RIDES AND MANŒUVRES,** by Lt.-Col. H. S. Jeudwine, R.A. 417

SVEN HEDIN'S EXPEDITION TO TIBET, by Major C. H. D. Ryder, D.S.O., R.E. (From the *Geographical Journal*) ... ... ... ... 43

**SWALLOW HOLES IN CHALK,** by Col. W. Pitt, late R.E. ... ... 365

**TELEGRAPH SYSTEM OF GREAT BRITAIN, THE MAIN UNDERGROUND,** by Major W. A. J. O'Meara, C.M.G., late R.E. ...191, 281

**TELEGRAPHY, FRENCH AND ENGLISH METHODS OF FIELD,** by Major E. G. Godfrey-Faussett, R.E. ... ... ... 351

**TENSION BRIDGE, PROPOSED,** by Capt. E. N. Mozley, R.E. ... 355

**TERRITORIAL FIELD COMPANIES, R.E.,** by Major F. E. G. Skey, R.E. ... ... ... ... ... ... ... 23

**TERRITORIALS OF THE 1st CENTURY B.C.,** by Col. O. E. Ruck, late R.E. ... .. ... ... ... ... ... 27

**TERRITORIALS OF THE ROMAN IMPERIAL ARMY, 1st CENTURY A.D.,** by Col. O. E. Ruck, late R.E. ... ... ... .. 363

**TRANSPORT, SOME POSSIBILITIES OF MODERN FORMS OF,** by Capt. R. Walker, R.E. ... ... ... ... ... 269

THE TRAINING OF THE 7TH ENGINEER REGIMENT OF THE FRENCH ARMY. Translated from the *Memorial de Ingenieros* by 'M' ... ... 477

**UNSTABLE TERRITORIALS OF IMPERIAL ROME, CIRCA 200 B.C.—100 A.D.,** by Col. O. E. Ruck, late R.E ... ... ... 437

**WINCHESTER CATHEDRAL, THE PRESERVATION OF,** by 2nd Lieut. J. M. Smeathman, R.E. ... ... ... ... ... 185

Digitized by Google

# Index to Authors.

(*Memoirs and Reviews Omitted.*)


| | Page. |
|---|---|
| A Company Officer ... ... | 261 |
| Baxter, J. G., Esq. ... ... | 439 |
| Beatty, Lieut. W. D. ... ... | 245 |
| Bell, Capt. A. H. ... ... ... | 141 |
| Close, Lt.-Col. C. F. ... ... | 169 |
| Dawson, P., Esq. ... .. ... | 329 |
| Dobbie, Capt. W. G. S. ... ... | 164 |
| Fenton, Lieut. G. C. V. ... ... | 494 |
| Gardiner, Capt. A. ... | 49, 181 |
| Godfrey-Faussett, Major E. G.... | 351 |
| Hartmann, Col. E. .. . . ... | 377 |
| Irvine, Capt. F. D.... ... ... | 13 |
| Jeudwine, Lt.-Col. H. S. ... ... | 417 |
| Lewis, Col. J. F. ... ... ... | 3 |
| 'M' ... ... .. ... ... | 477 |
| Martin, Lieut. A. D. de R. ... | 245 |
| Matheson, Major J. C. .. ... | 349 |
| Mozley, Capt. E.N. ... ... | 355 |
| McClintock, Bt. Major R. L. ... | 1 |
| Neame, Lieut. A. L. C. ... ... | 165 |
| O'Meara, Major W. A. J. ... | 191, 281 |
| Pitt, Col. W. ... ... ... | 365 |
| Riach, Major A. H. D. ... | 29, 89 |
| Ruck, Col. O. E. ... | 27, 363, 437 |
| Ryder, Major C. H. D. ... ... | 43 |
| Sankey, Capt. C. E. P. ... ... | 433 |
| Scott, 2nd Lieut. A. H. .. 41, | 137, 217 |
| Skey, Major F. E. G. ... ... | 23 |
| Smeathman, 2nd Lieut. J. M. ... | 185 |
| Tyrrell, Lieut. W. G. ... ... | 494 |
| Wace, Capt. E. G. ... ... ... | 307 |
| Walker, Capt. R. .. .. | 81, 269 |
| Ward, Lt.-Col. B. R. ... ... | 33, 129, 213, 297, 371, 455 |
| Williams, Capt. & Hon. Major G. B. | 107 |


Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

THIS BOOK IS DUE ON THE LAST DATE
STAMPED BELOW

BOOKS REQUESTED BY ANOTHER BORROWER
ARE SUBJECT TO RECALL AFTER ONE WEEK.
RENEWED BOOKS ARE SUBJECT TO
IMMEDIATE RECALL

LIBRARY, UNIVERSITY OF CALIFORNIA, DAVIS

Book Slip–Series 458

Digitized by Google

Nº 938130

TA
1
R75
n.s.
v.9

Royal engineers journal.

Digitized by Google

Digitized by Google